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Farmers' Handbook of

FINANCIAL CALCULATIONS and PHYSICAL MEASUREMENTS

Agriculture Handbook No. 230

U.S. DEPARTMENT OF AGRICULTURE
Economic Research Service
Farm Economics Division

Modern American farming is a complex business operation. As farms get bigger and investments higher, more and more figuring is required for determining the costs and returns of the farm business and for such things as depreciation, Social Security, credit, life insurance, retirement, and estate planning.

Today's farmer needs to be able to figure the interest rates charged by competing sellers and creditors, the size of installment required to pay off a debt at a specified interest rate over a given term, survivorship benefits payable to dependents under Social Security if he dies before retirement, and his own retirement income if he lives. He needs also to be able to convert life insurance proceeds into installment income for dependents in order to know whether Social Security and present life insurance will provide adequate incomes for them. And because financial computations are based on physical measurements, he needs to know such things as how to estimate acreages, yields in the field, and bushels in the bin.

This report is an attempt to make these and many other calculations easier for farmers and for county agents, country bankers, State and Federal employees, and others whom farmers call upon to advise and assist them. The calculations presented are those most frequently asked of Department of Agriculture and other public employees. The material is presented in question form with detailed solutions, so that the reader may solve similar problems with the help of the tables included in the report.

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CONTENTS

FARMERS' HANDBOOK OF FINANCIAL CALCULATIONS AND PHYSICAL MEASUREMENTS

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FINANCIAL CALCULATIONS

General Formula for Calculating Short-Term Interest Rates

An understanding of how to figure interest costs and rates could save you hundreds of dollars over a period of years. The following formula and problem solutions will help you determine whether lower interest rates are charged by one lender or seller than by another.

$$\text{Annual interest rate} = \frac{2 \times \text{number of payment periods in 1 year}^{1/} \times \text{interest}^{2/}}{\text{balance}^{3/} \times (\text{number of payments}^{4/} + 1)}$$

Expressed more compactly, the formula is:

$$r = \frac{2mI}{B\,(n+1)}$$

1/ Denoted by m in the compact formula. Regardless of the number of payments you make, when payments are made monthly, use 12 here; if made semimonthly, use 24; if every 2 months, use 6; if weekly, use 52, etc.

2/ Denoted by I in the compact formula. Time price minus cash price, or amount you pay back less the amount you receive in the case of a loan.

3/ Denoted by B in the compact formula. Cash price minus downpayment, or amount you get in the case of a loan.

4/ Denoted by n in the compact formula.

Example #1: You borrow \$100 from a bank for 6 months. The bank's discount rate is 4 percent a year, so it deducts \$2 from your loan and gives you \$98. You are to repay the \$100 in 6 months. What interest rate is being charged?

Solution: Since repayment is at the end of 6 months, there are two such payment periods in one year. Here $m = 2$. The interest charge I is \$2. The balance B is the \$98 you get. You repay the loan in one lump sum, so $n = 1$ and $n + 1 = 2$.

$$\text{Then } r = \frac{2 \times 2 \times 2}{98 \times 2} = 0.0408, \text{ or } 4.1 \text{ percent.}$$

Example #2: You borrow \$1,000 from a bank that charges a discount rate of 5 percent a year. You are to repay the loan in 3 years. The bank deducts \$150 from the loan (or 3 x 0.05 x 1,000) and gives you the remaining \$850. You are to pay back \$1,000 in 3 years. What interest rate is being charged?

Solution: Since the \$1,000 is to be repaid in 3 years, one year represents 1/3 of the payment period. Here $m = 1/3$. Only one payment is to be made, so $n = 1$ and $n + 1 = 2$. $I = \$150$ and $B = \$850$.

$$\text{Then } r = \frac{2 \times 1/3 \times 150}{850 \times 2} = \frac{2 \times 1 \times 150}{850 \times 3 \times 2} = 0.0588, \text{ or } 5.9 \text{ percent.}$$

Example #3: You borrow \$100 from a bank that charges 6 percent discount. You are to repay the loan in 18 months. The bank deducts \$9 from the loan (or 1.5 x 0.06 x 100) and gives you \$91. What interest rate is being charged?

Solution: Here $m = 2/3$, since a year represents only 12/18 or 2/3 of the payment period. $I = \$9$, $B = \$91$, and $n = 1$, so $n + 1 = 2$.

$$\text{Then } r = \frac{2 \times 2/3 \times 9}{91 \times 2} = \frac{2 \times 2 \times 9}{91 \times 3 \times 2} = 0.0659, \text{ or } 6.6 \text{ percent.}$$

Example #4: A bank advertises its "add-on" interest rate for new-car loans at 5 percent. On a \$1,000 loan paid back over 2 years, it would add \$100 (or 2 x 0.05 x 1,000) to the amount of the loan. The borrower would pay the \$1,100 in 24 payments, so his monthly payment would be \$45.83 (or 1,100 ÷ 24). What interest rate is being charged?

Solution: Here $I = 1{,}000 \times 2 \times 0.05 = \$100$; $B = \$1{,}000$; $n = 24$, $n+1 = 25$; and $m = 12$. If payments are to be made monthly, m is always 12. If payments are to be made weekly, $m = 52$; if semimonthly, $m = 24$; if quarterly, $m = 4$, and so on.

$$\text{Then } r = \frac{2 \times 12 \times 100}{1{,}000 \times 25} = .096, \text{ or } 9.6 \text{ percent.}$$

Installment purchases

Example #1: You can buy a refrigerator for \$200 cash or for \$20 down and 8 payments of \$25 each every 2 months. If you buy it on time, what interest rate is being charged?

Solution: The interest charge I is \$20 or the difference between the time price and the cash price.

Time price	= \$20 + (8 x \$25) =	\$220
Less cash price	------------	200
Interest charge I	-----------	20

The balance B is the cash price minus the downpayment, or \$200 - \$20, which is \$180. m = 6; n = 8 and n + 1 = 9.

$$\text{Then } r = \frac{2 \times 6 \times 20}{180 \times 9} = .148, \text{ or } 14.8 \text{ percent.}$$

Example #2: You can buy a TV set for \$200 cash or on time for \$10 down and 5 monthly payments of \$39 each. What interest rate is being charged if you buy on time?

Solution: The interest charge I is the time price less the cash price, or \$10 + (5 x \$39) - \$200, which is \$5. The balance B is the cash price minus the downpayment, or \$200 - \$10, which is \$190.

$$\text{Then } r = \frac{2 \times 12 \times 5}{190 \times 6} = 0.105, \text{ or } 10.5 \text{ percent.}$$

Example #3: You are considering making a time purchase from a mail-order house. Its catalog advertises that on a balance (after downpayment) of from \$180 to \$200, the company will add on \$25 as a service or time charge. You get 18 months to pay the time price.

The article you are interested in is listed at \$230, with \$30 down. What interest rate is being charged if you buy on time?

Solution: Your balance is \$200 (or 230 - 30). You would have to pay back \$225 (or \$200 plus the time charge of \$25), so each of your 18 monthly payments would be \$12.50 (which is 225 ÷ 18). Here m = 12; n = 18 and n + 1 = 19. The interest charge I is \$25.

$$\text{Then } r = \frac{2 \times 12 \times 25}{200 \times 19} = 0.158, \text{ or } 15.8 \text{ percent.}$$

Payment of Long-Term Loans by Regular Installments (Amortization)

In buying a farm or additional land, a long-term loan may be necessary. The following problems and their solutions explain how to determine the amount of a periodic payment that will amortize (pay off) a debt in a given time at a given interest rate, what your total payments will amount to, and how much of this total will be interest or the cost of the credit extended to you.

Use of Table 1 (principal and interest paid per $1 borrowed)

Example #1: After a downpayment on farmland, your balance is $10,000. It is to be amortized over 10 years by regular annual payments. The annual interest rate is 6 percent.

a) How much will you repay lender?
b) What will be your annual payment?
c) How much interest will you pay?

Solution:

a) 10,000 x 1.358680 = $13,586.80. The 1.358680 is found in the 6-percent column of table 1, opposite 10 annual payments.
b) 13,586.80 ÷ 10 = $1,358.68 per year.
c) 13,586.80 - 10,000 = $3,586.80 interest.

Example #2: Same as #1 except your payments are to be made semiannually.

Solution:

a) 10,000 x 1.344314 = $13,443.14. The 1.344314 is found in the 6-percent column of table 1 opposite 20 semiannual payments.
b) 13,433.14 ÷ 20 = $672.16 semiannually.
c) 13,443.14 - 10,000 = $3,443.14 interest.

Example #3: Same as #1 except your payments are to be made quarterly.

Solution:

a) 10,000 x 1.337084 = $13,370.84. The 1.337084 is found in the 6-percent column of table 1 opposite 40 quarterly periods.
b) 13,370.84 ÷ 40 = $334.27 per quarter.
c) 13,370.84 - 10,000 = $3,370.84 interest.

Example #4: Same as #1 except your payments are to be made monthly.

Solution:

a) 10,000 x 1.332246 = $13,322.46. The 1.332246 is found in the 6-percent column of table 1 opposite 120 monthly periods.
b) 13,322.46 ÷ 120 = $111.02 per month.
c) 13,322.46 - 10,000 = $3,322.46 interest.

Table 1.--Principal and interest paid per $1 borrowed, by term of loan and by interest rate

Frequency of payment	Number of payments	Annual interest rate 1/								
		4 percent	4 1/2 percent	5 percent	5 1/4 percent	5 1/2 percent	5 3/4 percent	6 percent	6 1/2 percent	7 percent
		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Annually--------	3	1.081046	1.091320	1.101626	1.106790	1.111962	1.117142	1.122329	1.132727	1.143155
	4	1.101960	1.114975	1.128047	1.134605	1.141178	1.147765	1.154366	1.167611	1.180912
	5	1.123135	1.138958	1.154874	1.162867	1.170882	1.178921	1.186982	1.203173	1.219453
	6	1.144571	1.163270	1.182105	1.191573	1.201074	1.210608	1.220176	1.239410	1.258775
	7	1.166267	1.187910	1.209739	1.220722	1.231751	1.242825	1.253945	1.276320	1.298873
	8	1.188223	1.212877	1.237774	1.250313	1.262912	1.275570	1.288288	1.313898	1.339742
	9	1.210437	1.238170	1.266211	1.280345	1.294555	1.308840	1.323200	1.352142	1.381378
	10	1.232909	1.263788	1.295046	1.310815	1.326678	1.342633	1.358680	1.391047	1.423775
	12	1.278626	1.315994	1.353905	1.373061	1.392351	1.411772	1.431324	1.470818	1.510824
	15	1.349116	1.396707	1.445134	1.469657	1.494384	1.519313	1.544441	1.595292	1.646919
	20	1.471635	1.537523	1.604852	1.639046	1.673587	1.708470	1.743691	1.815128	1.887859
	25	1.600299	1.685976	1.773812	1.818517	1.863734	1.909454	1.955668	2.049537	2.145263
	30	1.734903	1.841746	1.951543	2.007508	2.064162	2.121487	2.179467	2.297323	2.417592
	35	1.875206	2.004466	2.137510	2.205384	2.274123	2.343699	2.414085	2.557179	2.703189
	40	2.020940	2.173726	2.331126	2.411455	2.492814	2.575163	2.658462	2.827749	3.000366
Semiannually----	6	1.071155	1.080210	1.089300	1.093858	1.098425	1.103001	1.107585	1.116780	1.126009
	8	1.092078	1.103877	1.115739	1.121693	1.127664	1.133650	1.139651	1.151701	1.163813
	10	1.113265	1.127877	1.142588	1.149980	1.157397	1.164839	1.172305	1.187311	1.202414
	12	1.134715	1.152209	1.169846	1.178717	1.187625	1.196567	1.205545	1.223606	1.241807
	14	1.156428	1.176872	1.197511	1.207903	1.218344	1.228832	1.239369	1.260585	1.281990
	16	1.178402	1.201866	1.225584	1.237537	1.249554	1.261632	1.273774	1.298242	1.322957
	18	1.200638	1.227190	1.254061	1.267617	1.281251	1.294965	1.308757	1.336575	1.364703
	20	1.223134	1.252841	1.282943	1.298140	1.313435	1.328826	1.344314	1.375578	1.407222
	24	1.268906	1.305126	1.341908	1.360508	1.379247	1.398124	1.417138	1.455574	1.494548
	30	1.339498	1.385980	1.433329	1.457325	1.481533	1.505951	1.530578	1.580452	1.631140
	40	1.462230	1.527095	1.593449	1.627175	1.661260	1.695702	1.730495	1.801118	1.873091
	50	1.591160	1.675918	1.762903	1.807209	1.852046	1.897404	1.943275	2.036514	2.131686
	60	1.726078	1.832120	1.941204	1.996847	2.053201	2.110250	2.167978	2.298243	2.405317
	70	1.866736	1.995321	2.127798	2.195430	2.263953	2.333340	2.403564	2.546409	2.692267
	80	2.012857	2.165101	2.322084	2.402249	2.483474	2.565718	2.648940	2.818152	2.990791

Frequency of payment	Number of payments	Annual interest rate 1/								
		4 percent	4 1/2 percent	5 percent	5 1/4 percent	5 1/2 percent	5 3/4 percent	6 percent	6 1/2 percent	7 percent
		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Quarterly	12	1.066185	1.074624	1.083100	1.087351	1.091612	1.095881	1.100160	1.108744	1.117365
	16	1.087114	1.098298	1.109548	1.115197	1.120862	1.126544	1.132241	1.143685	1.155193
	20	1.108306	1.122306	1.136408	1.143497	1.150611	1.157750	1.164915	1.179319	1.193824
	24	1.129763	1.146648	1.163680	1.172250	1.180856	1.189499	1.198178	1.215645	1.233256
	28	1.151484	1.171324	1.191362	1.201455	1.211598	1.221789	1.232030	1.252659	1.273482
	32	1.173468	1.196331	1.219453	1.231110	1.242832	1.254618	1.266467	1.290357	1.314500
	36	1.195715	1.221670	1.247952	1.261214	1.274558	1.287982	1.301486	1.328735	1.356303
	40	1.218224	1.247340	1.276856	1.291765	1.306772	1.321879	1.337084	1.367789	1.398884
Monthly	6	1.011699	1.013166	1.014634	1.015368	1.016103	1.016838	1.017573	1.019044	1.020516
	9	1.016741	1.018844	1.020949	1.022002	1.023056	1.024111	1.025166	1.027278	1.029393
	12	1.021799	1.024542	1.027290	1.028665	1.030041	1.031419	1.032797	1.035557	1.038321
	18	1.031965	1.036003	1.040050	1.042077	1.044106	1.046137	1.048171	1.052246	1.056330
	24	1.042198	1.047547	1.052913	1.055603	1.058296	1.060993	1.063695	1.069110	1.074542
	36	1.062863	1.070889	1.078952	1.082998	1.087052	1.091116	1.095190	1.103364	1.111576
	48	1.083794	1.094568	1.105406	1.110850	1.116311	1.121788	1.127281	1.138318	1.149420
	60	1.104991	1.118581	1.132274	1.139159	1.146070	1.153006	1.159968	1.173969	1.188072
	120	1.214941	1.243661	1.272786	1.287500	1.302316	1.317230	1.332246	1.362576	1.393302
	180	1.331438	1.376987	1.423429	1.446980	1.470749	1.494738	1.518943	1.567993	1.617890
	240	1.454352	1.518358	1.583894	1.617226	1.650929	1.685002	1.719434	1.789375	1.860718
	300	1.583511	1.667496	1.753770	1.797744	1.842261	1.887318	1.932903	2.025621	2.120337
	360	1.718694	1.824066	1.932559	1.987934	2.044040	2.100863	2.158384	2.275445	2.395087

1/ For semiannual, quarterly and monthly payments, these are "nominal" rates; that is, an interest rate equal to 1/2, 1/4, or 1/12 of the quoted annual rate was used in preparing the table.

Amortization schedule

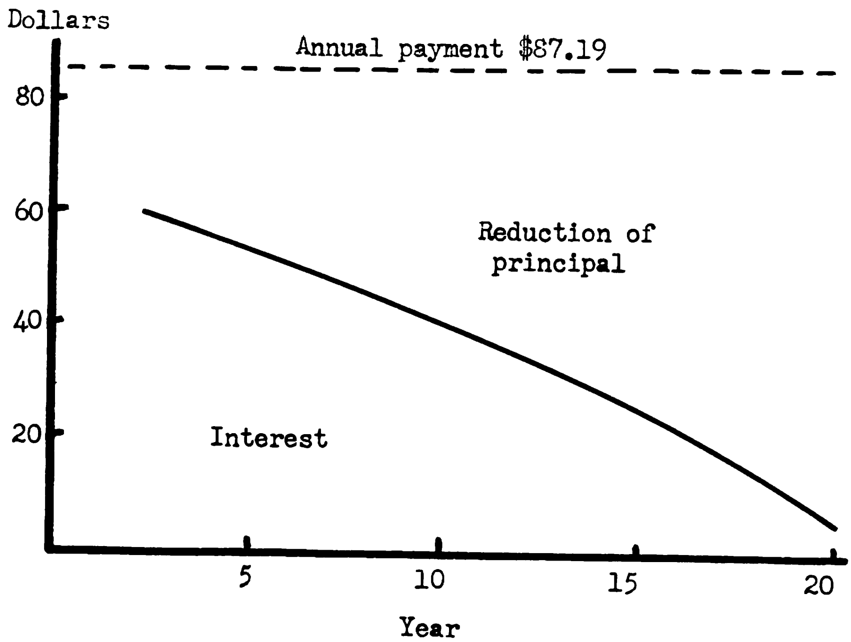
Month	End of month			
	Interest due 1/	Monthly payment	Reduction of principal	Balance outstanding
	Dollars	Dollars	Dollars	Dollars
At time of loan--	---	---	---	10,000.00
1st	50.00	111.02	61.02	9,938.98
2d	49.69	111.02	61.33	9,877.65
3d	2/ 49.39	111.02	3/ 61.63	9,816.02
118th	---	---	---	220.39
119th	1.10	111.02	109.92	110.47
120th	.55	111.02	110.47	0
Total 4/	3,322.46	13,322.46	10,000.00	---

1/ At 0.005 or one-half of 1 percent per month (since 0.06 ÷ 12 = 0.005).

2/ 9,877.65 x 0.005 = 49.39.

3/ 111.02 - 49.39 = 61.63.

4/ Due to rounding, columns may not add exactly to the totals shown.



Amortization of 20-year $1,000 6-percent loan by equal annual payments of $87.19

While the annual payment remains the same, the part applicable to interest declines, and the part applicable to reduction of the debt increases (see the amortization schedule above).

Depreciation

A farmer who does not charge depreciation as a cost in his farming operation is overstating his profits. In a way, he is "living off his principal." The depreciation of a machine, for example, is just as much an operating cost as the gasoline used to run it. And if he does not charge depreciation, he is paying more income taxes than he should pay. The following problems and their solutions explain how depreciation is calculated by two common methods.

Straight-line method

$$\text{Annual depreciation} = \frac{\text{cost - salvage}}{\text{years of life}}$$

Example: A tractor costs $3,200. You estimate that it has a probable life of 12 years and a salvage value of $200 at the end of that time. What is the annual depreciation on the machine? What is its carrying value at the end of 4 years? At the end of 6 years?

Solution:

$$\text{Annual depreciation} = \frac{3{,}200 - 200}{12} = \frac{3{,}000}{12} = \$250.$$

Carrying value:

At end of 4 years = 3,200 - (4 x 250) = $2,200.
At end of 6 years = 3,200 - (6 x 250) = $1,700.

Year	Annual depreciation	Carrying value 1/
	Dollars	Dollars
0	---	3,200
1	250	2,950
2	250	2,700
3	250	2,450
4	250	2,200
5	250	1,950
6	250	1,700
10	250	700
11	250	450
12	250	200
Total	3,000	---

1/ Value at which you would carry the tractor as an asset on your financial statement at end of year shown.

Sum-of-years-digits method

Example: Same as above.

Solution: Sum of years digits = 1 + 2 + 3 + . . . + 11 + 12 = 78.

$$\text{Also } 12 \times \frac{1 + 12}{2} = 6 \times 13 = 78.$$

Depreciation

1st year = (12/78) x (3,200 - 200) = 461.54.
2d year = (11/78) x 3,000 = (3,000/78) x 11 = 38.462 x 11 = 423.08.
3d year = 38.462 x 10 = 384.62.
4th year = 38.462 x 9 = 346.16.
6th year = 38.462 x 7 = 269.23.
11th year = 38.462 x 2 = (3,000/78) x 2 = (2/78) x 3,000 = 76.92.
12th year = 38.462 x 1 = (1/78) x 3,000 = 38.46.

Year	Annual depreciation	Carrying value 1/
	Dollars	Dollars
0		3,200.00
1	461.54	2,738.46
2	423.08	2,315.38
3	384.62	1,930.76
4	346.16	1,584.60
5	307.70	1,276.90
6	269.23	1,007.67
7	230.77	776.90
8	192.31	584.59
9	153.85	430.74
10	115.39	315.35
11	76.92	238.43
12	38.46	2/ 199.97
Total	3/ 3,000.03	---

1/ Value at which you would carry the tractor as an asset on your financial statement at end of year shown.
2/ Does not equal $200 because of rounding.
3/ Does not equal $3,000 because of rounding.

Accumulation of Specified Sum by Regular Deposits

If you save up and buy for cash, instead of buying on time, your income will go a lot further. You'll not only save finance charges, but your savings will also earn interest. So, if you can, save first and buy later. The following problems and their solutions show how to determine the periodic payment required to build up a "sinking fund" of a certain sum in a given time period at a given interest rate.

Use of tables 2 and 3 (payments required to accumulate $1)

If the number of months between deposits is the same duration as the interest-conversion period (table 2).

Table 2.--Periodic payment required at beginning of each period to accumulate $1 by the end of specified periods, at selected interest rates

Period	Interest rate								
	1 percent	1 1/4 percent	1 1/2 percent	2 percent	2 1/2 percent	3 percent	4 percent	5 percent	6 percent
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
1	0.99009901	0.98765432	0.98522167	0.98039216	0.97560976	0.97087379	0.96153846	0.95238095	0.9433962
2	.49258657	.49075991	.48894376	.48534265	.48178260	.47826295	.47134238	.46457607	.4579593
3	.32675456	.32513696	.32353001	.32034772	.31720699	.31410715	.30802744	.30210339	.2963300
4	.24384267	.24233187	.24083230	.23786642	.23494427	.23206509	.22643274	.22096365	.2156523
5	.19409881	.19265393	.19122101	.18839058	.18560669	.18286852	.17752607	.17235695	.1673550
6	.16093898	.15953956	.15815292	.15541746	.15273168	.15009466	.14496337	.14001664	.1352477
7	.13725572	.13589009	.13453809	.13187447	.12926383	.12670520	.12174001	.11697126	.1123915
8	.11949534	.11815618	.11683155	.11422529	.11167546	.10918096	.10435368	.09973506	.0953169
9	.10568353	.10436598	.10306386	.10050533	.09800672	.09556685	.09085865	.08637150	.0820964
10	.09463572	.09333637	.09205338	.08953581	.08708172	.08468981	.08008745	.07571864	.0715735
11	.08559809	.08431446	.08304812	.08056661	.07815215	.07580335			
12	.07806811	.07679833	.07554679	.07309764	.07071915	.06840979			
13	.07169784	.07044049	.06920232	.06678270	.06443734	.06216460			
14	.06623878	.06499274	.06376682	.06137448	.05906002	.05682169			
15	.06150869	.06027305	.05905848	.05669164	.05440630	.05220056			
16	.05737089	.05614491	.05494096	.05259816	.05034048	.04816587			
17	.05372085	.05250393	.05131001	.04899004	.04675880	.04461411			
18	.05047728	.04926892	.04808451	.04578637	.04358057	.04146475			
19	.04757599	.04637578	.04520046	.04292330	.04074206	.03865425			
20	.04496566	.04377322	.04260664	.04034972	.03819232	.03613175			
21	.04260470	.04141974	.04026175						
22	.04045913	.03928136	.03813134						
23	.03850083	.03733003	.03618793						
24	.03670641	.03554237	.03440798						
25	.03505619	.03389873	.03277188						
26	.03353354	.03238250	.03126301						
27	.03212428	.03097952	.02986726						
28	.03081627	.02967766	.02857249						
29	.02959903	.02846645	.02736826						
30	.02846348	.02733683	.02624550						
31	.02740171	.02628090	.02519635						
32	.02640682	.02529176	.02421389						
33	.02547271	.02436332	.02329206						
34	.02459403	.02349024	.02242550						
35	.02376602	.02266777	.02160949						
36	.02298446	.02189168	.02083980						
37	.02224559	.02115822	.02011268						
38	.02154604	.02046403	.01942476						
39	.02088277	.01980608	.01877303						
40	.02025307	.01918164	.01815478						

Example #1: You will need $400 for a new roof on your barn in 10 years. How much must you put aside annually, beginning now, in order to have the $400 in 10 years, if your savings earn 4 percent compounded annually?

Solution: Your deposits are made annually. Interest also is compounded annually. Both are 12-month periods; therefore, use table 2.

> 400 x 0.08008745 = 32.03. You must deposit $32.03 per year, beginning now. After 10 years, you will have deposited $320.30 (or 10 x 32.03). Interest of $79.70 will bring the total up to $400.
>
> The 0.08008745 is found in the 4-percent column of table 2 opposite 10 periods (years in this case).

Example #2: Same as #1 except your savings accumulate at 4 percent compounded semiannually and you make semiannual deposits. How much would you need to deposit every 6 months, beginning now, in order to have the $400 at the end of 10 years?

Solution: The payment period and the interest-conversion period are both 6 months. Therefore, use table 2.

> 400 x 0.04034972 = 16.14. You would need to deposit $16.14 every 6 months, beginning now. At the end of 10 years, you will have deposited $322.80 (or 20 x 16.14), but interest of $77.20 brings your savings up to $400.
>
> The 0.04034972 is found in the 2-percent column of table 2 opposite 20 payment periods. There are 20 payment periods and interest is at 2 percent per payment (semiannual) period.

Example #3: You want to save $1,800 in 6 years to send a son to college. How much would you need to put aside quarterly, beginning now, if your money earns 4 percent compounded quarterly?

Solution: 1,800 x 0.03670641 = 66.07. In 6 years (24 periods) you deposit $1,585.68 (or 24 x 66.07). Interest of $214.32 brings the total up to the $1,800 required. The 0.03670641 is found in the 1 percent (or 0.04 ÷ 4) column of table 2 opposite 24 quarterly periods.

Payments made more frequently or less frequently than interest is compounded (table 2 and 3).

Example #4: You want to accumulate $1,000 in 5 years to send your son to college. You can get 4 percent compounded quarterly on savings. How much would you need to deposit monthly, beginning now?

Solution: 1,000 x 0.04496566 x 0.33443953 = $15.04 per month. The 0.04496566 is found in the 1-percent column of table 2, opposite 20 periods. The quarterly rate is 1 percent, and there are 20 quarterly periods in the 5 years. But there is only one month between deposits, whereas there are 3 months in the interest-conversion period. Therefore, a correction factor of 0.33443953 must be used. It appears in the "1/3" column of table 3, opposite 1 percent.

Table 3.--Accumulation of fund by periodic payments: Correction factors to be used with table 2 to determine amount of periodic payments when number of months between payments is not the same as the number of months in the interest-conversion period

Interest rate per conversion period 1/	Number of months between payments ÷ number of months in interest conversion period								
	12	6	4	2	1/2	1/3	1/4	1/6	1/12
	Correction factor to be used								
1	11.36762824	5.85343123	3.94098521	1.99009901	.50124379	.33443953	.25093361	.16735842	.08371391
1 1/4	11.21780337	5.81783504	3.92653370	1.98765432	.50155281	.33471456	.25116581	.16753053	.08380862
1 1/2	11.07111779	5.78264498	3.91220042	1.98522167	.50186107	.33498899	.25139753	.16770231	.08390317
2	10.78684804	5.71345951	3.88388327	1.98039216	.50247531	.33553603	.25185955	.16804487	.08409176
2 1/2	10.51420872	5.64582849	3.85602357	1.97560975	.50308653	.33608069	.25231968	.16838613	.08427968
3	10.25262411	5.57970718	3.82861135	1.97087379	.50369478	.33662298	.25277792	.16872608	.08446694
4	9.76047671	5.45182233	3.77509103	1.96153846	.50490243	.33770056	.25368887	.16940215	.08483949
5	9.30641422	5.32947666	3.72324802	1.95238095	.50609847	.33876891	.25459250	.17007314	.08520944
6	8.88687458	5.21236379	3.67301195	1.94339623	.50728310	.33982821	.25548895	.17073916	.08557684

1/ If interest is at 4 percent compounded quarterly, for example, the quarterly rate of 1 percent in this column would be applicable. If payments are monthly, the number of months between payments divided by the number of months in the interest period would be 1/3. The applicable correction factor from this table would be .33443953.

Example #5: Same as above except you want to make semiannual, instead of monthly, deposits. How much would you need to deposit every 6 months beginning now?

Solution: 1,000 x 0.04496566 x 1.99009901 = $89.49 semiannually. The 1.99009901 is found in the column headed "2", opposite 1 percent, in table 3. There are 6 months between deposits and only 3 months in the interest-conversion period. Therefore, the ratio 6/3 = 2; we look opposite 1 percent in the column designated as "2" in table 3.

Example #6: Same as #4 except you want to make your deposits every 3 months. How much would these deposits be, beginning now?

Solution: 1,000 x 0.04496566 = $44.97 quarterly. No correction factor from table 3 is needed, since the payment period and the interest-conversion period are the same length (3 months). The 0.04496566 is from the 1-percent column of table 2, opposite 20 quarterly periods. This problem is handled from table 2 in the same way as examples #1, #2, and #3.

Example #7: You want to save $1,800 in 6 years to send a son to college. How much would you need to deposit annually, beginning now, if your savings earn 4 percent compounded quarterly?

Solution: 1,800 x 0.03670641 x 3.94098521 = $260.39 per year. The 0.03670641 is found in the 1-percent column of table 2, opposite 24 interest periods. The interest rate is 1 percent quarterly (0.04 ÷ 4), and there are 24 quarters in the 6-year period.

Then, since there are 12 months between deposits and only 3 months between interest conversions (12/3 = 4), look in the "4" column of table 3 for a correction factor. Use 3.94098521, which is found in the "4" column of table 3 opposite the 1-percent interest rate.

Life Insurance

Tables 4 and 5 are useful in planning life insurance to fit your needs. From these tables, you can determine how far a given amount of life insurance proceeds would go in providing a monthly income for your widow and other dependents in case of your death.

An option under which you may elect a monthly income for your widow, instead of a lump-sum payment of the face amount, or under which she may so elect if you do not choose one of the optional modes of settlement, is included in every policy. Therefore, each policy includes a table showing the money incomes applicable to various income periods from which a choice may be made. The monthly incomes shown in this table are based on the guaranteed interest rate stated in the policy.

Companies may pay more than the guaranteed rate when warranted by current investment earnings. To be on the conservative side, the monthly incomes shown in the above-mentioned table (the same as one of the columns of table 4) or computed from table 5, which are based on a guaranteed interest rate, should be used for planning purposes.

Table 5.--Life insurance monthly income to beneficiary per $1,000 of policy face amount, by type of settlement option and by age of widow at time of death of insured husband 1/

Age of widow (years)	Monthly income per $1,000 of insurance	
	Life annuity 2/	Life annuity with 10 years certain 3/
	Dollars	Dollars
35	3.27	3.26
36	3.31	3.30
37	3.36	3.34
38	3.40	3.39
39	3.45	3.43
40	3.50	3.48
41	3.56	3.53
42	3.61	3.59
43	3.67	3.64
44	3.73	3.70
45	3.79	3.76
46	3.86	3.82
47	3.93	3.88
48	4.00	3.95
49	4.08	4.02
50	4.16	4.09
51	4.24	4.17
52	4.32	4.25
53	4.42	4.33
54	4.51	4.42
55	4.61	4.50
56	4.72	4.60
57	4.83	4.69
58	4.95	4.79
59	5.07	4.90
60	5.20	5.01
61	5.34	5.12
62	5.48	5.23
63	5.64	5.35
64	5.80	5.48
65	5.97	5.61
66	6.15	5.74
67	6.34	5.87
68	6.54	6.01
69	6.75	6.16
70	6.97	6.30

1/ Calculations are based on 1937 Standard Annuitants' Mortality Table and a 2 1/2 percent interest rate, with female life "aged back" 6 years, and with no "loading" for operating expenses. These are "annuities due," that is, payments are at beginning of each monthly period. For male beneficiaries, subtract 5 years from ages shown. For example, the monthly incomes for a female aged 45 are applicable to a male aged 40.

2/ Payments cease upon death of beneficiary.

3/ If beneficiary dies before the end of 10 years, payments continue to the estate for the remainder of the original 10-year period. If beneficiary dies after 10 years, payments cease at that time.

Payments "certain" with no life contingency

Example #1: Suppose you have $5,000 worth of life insurance. You want to know what monthly income it would provide for, say, 10 years in case of your death.

Solution: Look in the section of your policy dealing with settlement options, and find the interest rate applicable to proceeds retained by the company. Many policies issued since 1948 are at 2 1/2 percent. Suppose yours is also 2 1/2 percent.

Then, looking in the 2 1/2 percent column of table 4, opposite 10 years, we see that $1,000 would provide $9.39 per month, so $5,000 would provide $46.95 per month (or 5 x 9.39). The table in your policy shows the same figures as the "2 1/2" percent column of table 4.

Example #2: You decide that $46.95 is too little. You want to know how far the $5,000 would go at $100 a month.

Solution: Divide 100 by 5 to get $20 per month. Each $1,000 of insurance must provide $20 a month. Looking for $20 in the 2 1/2 percent column of table 4, we find that it falls between $21.86 for 4 years and $17.70 for 5 years; so the $5,000 of insurance proceeds would provide $100 a month for between 4 and 5 years. 5/

Payments involving a (single) life contingency

Straight life annuity

Example #1: You have $10,000 of life insurance and want to use it to provide the maximum monthly income for your widow for the remainder of her life. She is now aged 55. If you should die now, how much would she get per month under a life annuity elected by you or her?

Solution: Each $1,000 of proceeds would provide $4.61 per month, so your $10,000 would provide $46.10 per month (or 10 x 4.61). The 4.61 is found in the "Life annuity" column of table 5, opposite widow's age 55.

Under this option, if she died soon, payments would stop. But if she lived to very old age, her payments would continue to the end of her life.

Life annuity with 10 years of payments guaranteed

Example #2: Under the same conditions, how much would be provided by a life annuity with 10 years of payments certain?

5/ For greater accuracy, interpolation is required, as follows: $\frac{21.86 - 20}{21.86 - 17.70} = \frac{1.86}{4.16} = 0.447$. Therefore, a more precise answer would be 4.447 years or 4 years and 5 months.

Solution: Under this option, $4.50 per month per $1,000 would be payable to a widow aged 55. The $10,000 of face amount therefore would provide $45 (or 10 x 4.50). The 4.50 is found in the "Life annuity with 10 years certain" column of table 5, opposite widow's age 55.

In comparison with the straight life annuity, used in example #1, this option would reduce the monthly income by $1.10 per month. Under it, the company would make payments to the estate for the remainder of the 10-year guaranteed period (beginning at date of your death) if your widow should die before the end of the 10 years. If she should live beyond the 10 years, her payments would continue to the end of her life, as in the case of the straight life annuity in example #1 above.

Example #3: How much life insurance would be required to provide your widow with a monthly income of $150 under a "10-years-certain" life annuity, as explained in #2 above? She is now aged 65.

Solution: At age 65, each $1,000 would buy $5.61 per month. The 5.61 is found in the "Life annuity with 10 years certain" column of table 5, opposite age 65. Then 150/5.61 = 26.738, so it would take $26,738 of life insurance to provide the monthly income of $150. You could get a policy for, say, $27,000. If you already have a policy for $10,000, you would need about $17,000 more insurance to provide the desired monthly income for your widow.

Under a straight life annuity (no payments certain), the $26,738 of proceeds would buy $159.63 per month (or 26.738 x 5.97). (See table 5.) The term certain therefore reduces the monthly payments by $9.63 (difference between $159.63 and $150). A term certain reduces the monthly payments much more at the older than at the younger ages (fig. 1).

Joint life and two-thirds survivorship annuity

Based on joint life expectancies, table 6 can be used to convert a lump sum, for example, life insurance cash values, into monthly (annuity) incomes for a husband and wife during their remaining years. The survivor gets only two-thirds as much as the couple received while both were alive. Two examples of use of the table are given.

Under this type of annuity, the amounts shown in table 6 are payable while both husband and wife are alive. After one (either one) dies, the survivor gets two-thirds of the amounts shown in table 6. The last survivor receives her (or his) annuity until death. There is no refund for early death of both annuitants.

Example #1: Suppose you are aged 65; your wife is 62. You are both eligible for OASDI (social security) benefits. You have an endowment-at-age-65 policy which matures soon for $5,000. 6/ You want to know how

6/ The $5,000 might also represent the cash value of a longer term endowment, or the cash value of a limited pay or an ordinary life policy, for a greater face amount than $5,000.

Table 6.--Monthly payments for life that $1,000 will buy as a joint life and two-thirds survivorship annuity 1/

Age of husband (years)	Husband older than wife by —					Same age	Wife older than husband by —		
	5 years	4 years	3 years	2 years	1 year		1 year	2 years	3 years
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
50----------	3.90	3.94	3.98	4.02	4.06	4.10	4.14	4.18	4.23
51----------	3.97	4.01	4.05	4.10	4.14	4.18	4.22	4.27	4.32
52----------	4.05	4.09	4.13	4.18	4.22	4.27	4.31	4.36	4.41
53----------	4.13	4.17	4.22	4.26	4.31	4.36	4.40	4.45	4.50
54----------	4.21	4.26	4.30	4.35	4.40	4.45	4.50	4.55	4.61
55----------	4.30	4.34	4.39	4.44	4.50	4.55	4.60	4.66	4.71
56----------	4.39	4.44	4.49	4.54	4.60	4.65	4.71	4.77	4.83
57----------	4.48	4.53	4.59	4.65	4.70	4.76	4.82	4.88	4.95
58----------	4.58	4.64	4.70	4.76	4.82	4.88	4.94	5.01	5.07
59----------	4.69	4.75	4.81	4.87	4.94	5.00	5.07	5.14	5.20
60----------	4.80	4.86	4.93	4.99	5.06	5.13	5.20	5.27	5.34
61----------	4.91	4.98	5.05	5.12	5.19	5.26	5.34	5.41	5.49
62----------	5.03	5.11	5.18	5.25	5.33	5.41	5.48	5.56	5.65
63----------	5.16	5.24	5.32	5.39	5.47	5.56	5.64	5.72	5.81
64----------	5.30	5.38	5.46	5.54	5.63	5.72	5.80	5.89	5.98
65----------	5.44	5.52	5.61	5.70	5.79	5.88	5.97	6.07	6.17
66----------	5.59	5.68	5.77	5.87	5.96	6.06	6.16	6.26	6.36
67----------	5.75	5.85	5.94	6.04	6.14	6.25	6.35	6.46	6.57
68----------	5.92	6.02	6.12	6.23	6.34	6.45	6.56	6.67	6.79
69----------	6.10	6.21	6.32	6.43	6.54	6.66	6.78	6.90	7.02
70----------	6.29	6.40	6.52	6.64	6.76	6.88	7.01	7.13	7.26

1/ Based on 1937 Standard Annuitants' Mortality Table and a 2 1/2 percent interest rate. Male life "aged back" 1 year in the calculations; female life, 6 years. No loading for expenses has been included, under assumption the joint life annuity is available as an option in a life insurance policy. If a policy were "cashed" and its proceeds used to buy the joint life annuity, the monthly incomes provided would be about 93.5 percent of the amounts shown in this table. Under this type of joint life annuity, the monthly payments shown are payable while both husband and wife are living. After one dies, the other is paid only two-thirds of the amounts shown.

much monthly income the $5,000 would provide under a joint life and two-thirds survivorship annuity, as described above. You want to supplement your social security money with this additional income.

Solution: (5,000/1,000) x 5.61 = $28.05 per month. After one of you dies, the survivor gets $18.70 per month. The 5.61 is found in row "65" for age of husband, and under column headed "Husband older than wife by 3 years."

Example #2: A son would be willing to take over the operation of your farm. However, it represents your life savings, so you must have a retirement income from it. If it is agreed that the value of the farm is $60,000 (after deducting for use of the dwelling by the parents during their remaining years), how much income per month would this sale value provide under a joint life and two-thirds survivorship annuity? The father is 62, his wife is 58.

Solution: (60,000/1,000) x 5.11 = $306.60 per month.

In accordance with the agreement, the son would pay his parents $306.60 per month as long as both were alive. After the death of one, the son would pay the survivor $204.40 per month. The son would not be relieved of his debt until both parents were dead. If one or both lived long, he would still be required to meet his payments; if both died early, his debt would be paid off. All children should understand how the agreement works. In effect, the son would be assuming the responsibilities of a life insurance company. This procedure does provide, however, a way in which a farm can be passed along to a son (or son-in-law) as a going operation.

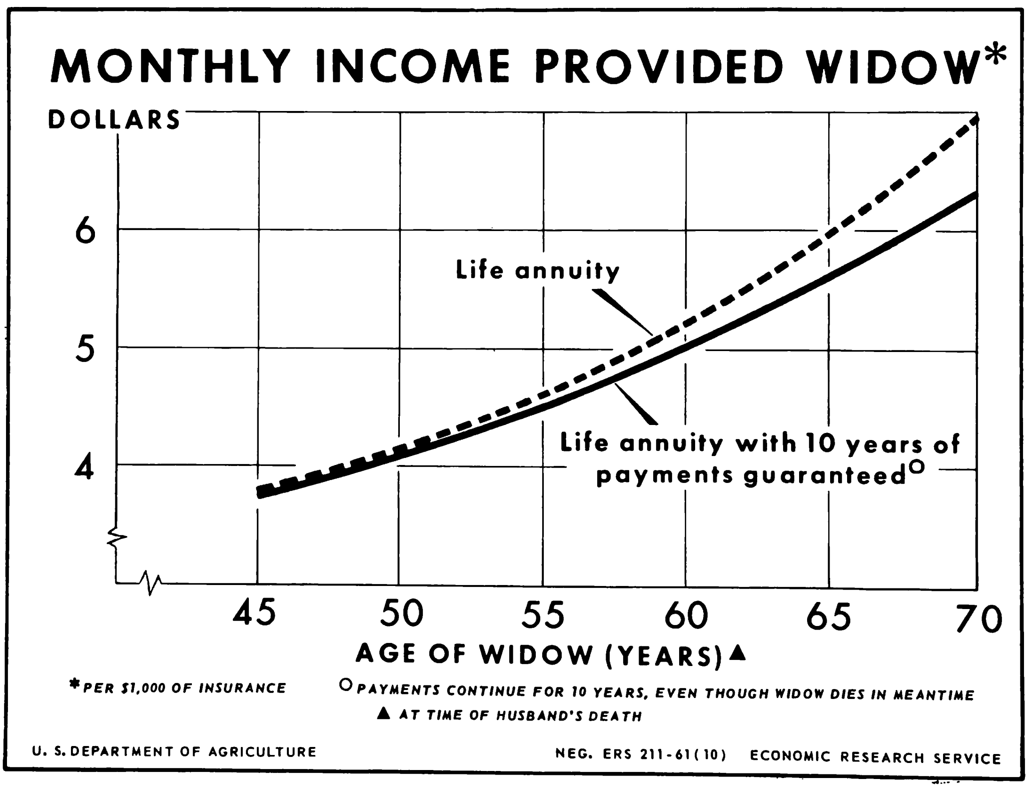


Figure 1

Social Security

Unless you can estimate or find out from your local Social Security office (1) how much monthly income your widow and dependent children would get from Social Security if you died, you cannot (2) estimate whether your present life insurance and other income is adequate for them. And you can't plan your own retirement unless (3) you know about what your Social Security retirement income will be if you live. Table 7 is used in solving problems under (1), and tables 7 and 8 are used in solving problems under (3). Problems coming under (2) are solved in other parts of the report.

> The benefits payable under social security may change from time to time as new legislation is passed. The payments shown or calculated in this report were in effect after the 1961 amendments.

In all life insurance and estate planning, survivorship and retirement benefits payable under social security are considered first. A person is "currently" insured if he worked in covered employment at least half of the time during the 3 years before he dies. He is "fully" insured if he worked at least one-fourth of the quarters since 1950. If he is fully insured at the time of his death, his family is entitled to survivorship benefits if there are children then under age 18. Moreover, if he is fully insured, he and his wife (and any children then under 18) are entitled to retirement benefits at age 62.

Both survivorship and retirement benefits depend on average earnings under social security, as evidenced by income-tax returns. For those qualifying, these monthly payments cannot be less than certain established minimums. There is also a family maximum.

$$\text{Average monthly earnings} = \frac{\text{gross earnings 1951 to date of death or retirement (after dropout of up to 5 years of lowest income)}}{\text{elapsed months since January 1, 1951, or subsequent "entry" (after dropout of up to 60 months)}}$$

There are 5 steps involved in this calculation:

1. You need your gross earnings figures for every year since 1950.
2. Drop your lowest 5 years.
3. Add up your remaining income to get total income for these years.
4. Add up elapsed months in the years for which you use the earnings.
5. Divide the figure obtained in step 3 by the figure obtained in step 4.

> If you will take your earnings record by individual years to your local social security office, someone there can furnish you with survivor-benefit figures or even a retirement income estimate based on it.

Table 7.--Social Security: Reduced PIA's, survivorship benefits, and retirement benefits for husband 64, wife 63, by average monthly wages

Average monthly wages	Reduced PIA 1/	Survivorship benefits: Widow 62 or over, no children under age 18	Survivorship benefits: Widow under 62 with this number of children under age 18: 1	Survivorship benefits: Widow under 62 with this number of children under age 18: 2	Survivorship benefits: Family maximum 2/	Retirement benefits: Husband 64, wife 63 3/ 1.6875 x (1)
	(1)	(2)	(3)	(4)	(5)	(6)
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
67 or less---	32.00	40.00	60.00	60.00	60.00	54.00
68-69-------	32.80	40.00	61.60	61.50	61.50	55.40
70----------	33.60	40.00	63.00	63.00	63.00	56.70
71-72-------	34.40	40.00	64.60	64.50	64.50	58.10
73-74-------	35.20	40.00	66.00	66.00	66.00	59.40
75-76-------	36.00	40.00	67.60	67.50	67.50	60.80
77-78-------	36.80	40.00	69.00	69.00	69.00	62.10
79-80-------	37.60	40.00	70.60	70.50	70.50	63.50
81----------	38.40	40.00	72.00	72.00	72.00	64.80
82-83-------	39.20	40.50	73.60	73.50	73.50	66.20
84-85-------	40.00	41.30	75.00	75.00	75.00	67.50
86-87-------	40.80	42.10	76.60	76.50	76.50	68.90
88-89-------	41.60	42.90	78.00	78.00	78.00	70.20
90----------	42.40	43.80	79.60	79.50	79.50	71.60
91-92-------	43.20	44.60	81.00	81.00	81.00	72.90
93-94-------	44.00	45.40	82.60	82.50	82.50	74.30
95-96-------	44.80	46.20	84.00	84.00	84.00	75.60
97----------	45.60	47.10	85.60	85.50	85.50	77.00
98-99-------	46.40	47.90	87.00	87.00	87.00	78.30
100-101-----	47.20	48.70	88.60	88.50	88.50	79.70
102---------	48.00	49.50	90.00	90.00	90.00	81.00
103-104-----	48.80	50.40	91.60	91.50	91.50	82.40
105-106-----	49.60	51.20	93.00	93.00	93.00	83.70
107---------	50.40	52.00	94.60	94.50	94.50	85.10
108-109-----	51.20	52.80	96.00	96.00	96.00	86.40
110-113-----	52.00	53.70	97.60	97.50	97.50	87.80
114-118-----	52.80	54.50	99.00	99.00	99.00	89.10
119-122-----	53.60	55.30	100.60	100.50	100.50	90.50
123-127-----	54.40	56.10	102.00	102.00	102.00	91.80
128-132-----	55.20	57.00	103.60	105.60	105.60	93.20
133-136-----	56.00	57.80	105.00	108.90	108.80	94.50
137-141-----	56.80	58.60	106.60	112.80	112.80	95.90
142-146-----	57.60	59.40	108.00	117.00	116.80	97.20
147-150-----	58.40	60.30	109.60	120.00	120.00	98.60
151-155-----	59.20	61.10	111.00	124.20	124.00	99.90
156-160-----	60.00	61.90	112.60	128.10	128.00	101.30
161-164-----	60.80	62.70	114.00	131.40	131.20	102.60
165-169-----	61.60	63.60	115.60	135.30	135.20	104.00

See footnotes at end of table.

Table 7.--Social Security: Reduced PIA's, survivorship benefits, and retirement benefits for husband 64, wife 63, by average monthly wages --Continued

Average monthly wages	Reduced PIA 1/	Survivorship benefits: Widow 62 or over, no children under age 18	Survivorship benefits: Widow under 62 with this number of children under age 18: 1	Survivorship benefits: Widow under 62 with this number of children under age 18: 2	Survivorship benefits: Family maximum 2/	Retirement benefits: Husband 64, wife 63 3/ 1.6875 x (1)
	(1)	(2)	(3)	(4)	(5)	(6)
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
348-351-----	92.80	95.70	174.00	254.10	254.00	156.60
352-356-----	93.60	96.60	175.60	254.10	254.00	158.00
357-361-----	94.40	97.40	177.00	254.10	254.00	159.30
362-365-----	95.20	98.20	178.60	254.10	254.00	160.70
366-370-----	96.00	99.00	180.00	254.10	254.00	162.00
371-375-----	96.80	99.90	181.60	254.10	254.00	163.40
376-379-----	97.60	100.70	183.00	254.10	254.00	164.70
380-384-----	98.40	101.50	184.60	254.10	254.00	166.10
385-389-----	99.20	102.30	186.00	254.10	254.00	167.40
390-393-----	100.00	103.20	187.60	254.10	254.00	168.80
394-398-----	100.80	104.00	189.00	254.10	254.00	170.10
399-400-----	101.60	104.80	190.60	254.10	254.00	171.50

1/ A farmer who retires at age 62, and whose wife is less than 62, would receive amounts shown in this column until she became 62.

2/ Amounts in this column applicable to a widow less than 62, with 3 or more children under age 18.

3/ Because of rounding of figures applicable to individuals, a few figures in this column are 10 or 20 cents less than the actual amounts would be. The age-combination factor "1.6875" comes from table 8.

Table 8.--Social security retirement income of couple retiring between ages 62 and 65, per dollar of husband's reduced PIA for age 62

Age of husband	Age of wife: 62	Age of wife: 63	Age of wife: 64	Age of wife: 65
	Dollars	Dollars	Dollars	Dollars
62-------------------	1.468750	1.520833	1.572917	1.625000
63-------------------	1.552083	1.604167	1.656250	1.708333
64-------------------	1.635417	1.687500	1.739583	1.791667
65-------------------	1.718750	1.770833	1.822917	1.875000

The basis for all survivor benefits to your family in case of your death, and to you and your wife if you both live to retirement, is the primary insurance amount (PIA), which is based on your average monthly earnings under social security. 7/ The maximum income that could be counted was changed in a recent year from $4,200 to $4,800. The year of change is not important, as you can get a statement of your social security earnings from the Social Security Administration that will show all earnings that can be counted, in accordance with the maximums that were in effect when the earnings were made.

Table 7 shows reduced PIA's, survivorship benefits, and the retirement benefits applicable to a husband aged 64 and wife aged 63, by average monthly wages. More attention will be given to retirement benefits for other husband-and-wife age combinations later.

Survivorship benefits

Example #1: A widow is aged 35 at the time of her husband's death; their only child is aged 13. The husband was fully insured. His covered earnings averaged $284 per month. What monthly benefit will his family receive? How long will they receive these benefits?

Solution: For average monthly earnings of $284, the family benefit for a widow with one child under 18 is $153 (from table 7). The family will receive this $153 per month for 5 years, or until the child is 18. Then all payments will stop. At 62, if she has not remarried, the widow will begin to receive payments of $84.20 per month. 8/

Example #2: A widow is aged 40 at the time of her husband's death; their children are aged 6 and 10. At his death, the husband was fully insured. His covered earnings averaged $258 per month. What monthly benefit will his family receive? For how long?

Solution: For average monthly wages of $258, the benefit for a widow with 2 dependent children is $206.40 per month (found in column 4, table 7, opposite average monthly wages of $258).

When the older child is 18, the younger child will be 14. Then payments to the widow and younger child will drop to $144 per month (found in column 3, table 7, opposite average monthly wages of $258).

When this younger child is 18, the widow will be 52. Then all social security payments will stop until she reaches 62. At that time, she will start receiving checks for $79.20 (found in column 2, table 7, opposite average monthly wages of $258). She will continue receiving them until she dies or remarries.

7/ In this report, the husband's primary insurance amount applicable to age 62 will be referred to as the "reduced PIA."

8/ The $84.20 is found in column (3) of table 7, opposite average monthly wages of $284 per month.

Example #1: A farmer retires at 62, at which time his wife is aged 60. His covered earnings averaged $261 per month. What will be their combined social security income?

Solution: Nothing is payable for the wife until she reaches 62. The payment for the husband is his reduced PIA applicable to average monthly wages of $261. This figure (from column 1 of table 7) is $77.60 per month. When she becomes 62, their check will be increased to $114 (or 1.46875 x 77.60). 9/ The payment for him does not change. He continues to receive 100 percent of his reduced PIA, since his checks started at age 62. But the payment for her amounts to 0.46875 x 77.60 or $36.40. 10/ The total of $114 (or 77.60 + 36.40) is 1.46875 x his reduced PIA (after rounding). The 1.46875 is given in table 8 for husband aged 62 (at entry, even though he is now 64) and for wife aged 62 at entry.

Example #2: A farmer retires at age 64; his wife is 63. If his covered earnings since 1950 averaged $340 per month after a dropout of up to 5 years of lowest income, what will be their combined social security retirement income per month?

Solution: His reduced PIA applicable to age 62 would be $91.20 (from column 1 of table 7 opposite average monthly wages of $340). Then 1.6875 x 91.20 = $153.90. The 1.6875 is found in table 8 opposite age 64 for age of husband, under column headed "63" for age of wife.

The family social security retirement income for a husband retiring at age 64, with wife then aged 63 and no children under 18, is shown, by average monthly wages, in column 6, table 7. Therefore, the $153.90 also might have been found in column 6, table 7, opposite average monthly wages of $340.

Example #3: Same as #2 except let's assume that this farmer is 5 months past his 64th birthday at the time of his retirement, and that his wife is 9 months past her 63rd birthday at that time. What will be the couple's social security retirement income?

Solution: Use the following formula for fractional ages between 62 and 65 inclusive —

$$\text{Retired couple's annuity} = \text{Reduced PIA} \left[(1 + N/144) + \frac{15}{32}\,(1 + n/108) \right]$$

where N = number of months husband is past his 62d birthday, and n = number of months his wife is past her 62d birthday.

9/ 1.46875 x 77.60 = 113.975. It is then rounded upward to nearest 10 cents, that is, to $114.

10/ 0.46875 x 77.60 = 36.375. It is then rounded upward to nearest 10 cents, that is, to $36.40.

Table 9.--"Life" of a lump-sum deposit which earns interest while a regular monthly income is withdrawn from it

Interest earned on deposit, and frequency of compounding	If this percentage of the lump-sum deposit is withdrawn each month					
	0.65	0.75	1	2	3	4
	Fund will last this long:					
	Years	Years	Years	Years	Years	Years
4 percent, compounded —						
Annually	17.86	14.62	10.11	4.56	2.95	2.18
Semiannually	17.94	14.67	10.13	4.56	2.95	2.18
Quarterly	17.99	14.70	10.14	4.56	2.95	2.18
Monthly	18.01	14.72	10.15	4.57	2.95	2.18
5 percent, compounded —						
Annually	20.20	16.06	10.73	4.67	2.99	2.20
Semiannually	20.38	16.16	10.77	4.68	2.99	2.20
Quarterly	20.47	16.22	10.79	4.68	3.00	2.20
Monthly	20.53	16.25	10.80	4.68	3.00	2.20
6 percent, compounded —						
Annually	23.71	17.97	11.44	4.79	3.04	2.23
Semiannually	24.13	18.17	11.52	4.80	3.04	2.23
Quarterly	24.29	18.28	11.56	4.80	3.05	2.23
Monthly	24.50	18.36	11.58	4.81	3.05	2.23

Lump sum used to provide income for specified period

Example #1: Suppose your wife is aged 50 and your youngest child is aged 13. When this child is 18, your wife will be 55. If you should die in the meantime, your widow would not be eligible for a social security survivorship annuity between the ages of 55 and 62. During this 7-year period, she would have to rely on income from life insurance proceeds or from other sources.

If you had $10,000 of life insurance, and your widow invested that amount of proceeds at 4 percent compounded semiannually, how much could she withdraw from her account each month and still be sure that, with interest, the fund would last for 7 years?

Solution: 10,000 x 0.01365 = $136.50 per month. The 1.365 percent is found in the column headed "4 percent compounded semiannually" of table 10, opposite "7" years. If she deposited the $10,000 at age 55, her fund would last until she was 62.

Example #2: How much life insurance would you need, under the situation described in example #1, to provide your widow with $200 per month during this 7-year period?

Table 10.--Percentage of lump-sum deposit (which earns interest) that may be withdrawn monthly in order for the deposit to last a specified number of years

Year	Interest earned								
	4 percent, compounded —			5 percent, compounded —			6 percent, compounded —		
	Annually	Semi-annually	Quarterly	Annually	Semi-annually	Quarterly	Annually	Semi-annually	Quarterly
	Percentage of deposit that may be withdrawn monthly								
2	4.339	4.341	4.342	4.382	4.385	4.386	4.425	4.429	4.431
3	2.949	2.951	2.952	2.992	2.995	2.996	3.035	3.039	3.041
4	2.255	2.256	2.257	2.298	2.301	2.302	2.341	2.345	2.347
5	1.838	1.840	1.841	1.882	1.885	1.886	1.926	1.930	1.932
6	1.561	1.563	1.564	1.605	1.608	1.609	1.650	1.654	1.656
7	1.364	1.365	1.366	1.408	1.411	1.412	1.453	1.457	1.459
8	1.216	1.217	1.218	1.261	1.264	1.265	1.306	1.311	1.313
9	1.101	1.103	1.103	1.146	1.149	1.150	1.193	1.197	1.199
10	1.009	1.011	1.012	1.055	1.058	1.059	1.102	1.107	1.109
11	.934	.936	.937	.981	.984	.985	1.029	1.033	1.035
12	.872	.874	.875	.919	.922	.924	.968	.972	.974
13	.820	.822	.822	.867	.870	.872	.916	.921	.923
14	.775	.775	.778	.823	.826	.828	.873	.877	.880
15	.736	.738	.739	.785	.788	.790	.835	.840	.842
16	.702	.704	.705	.752	.755	.757	.803	.807	.810
17	.673	.675	.676	.723	.726	.728	.774	.779	.781
18	.647	.649	.650	.697	.700	.702	.749	.754	.756
19	.623	.625	.626	.674	.677	.679	.727	.732	.734
20	.602	.604	.605	.654	.657	.659	.707	.712	.715
21	.583	.585	.586	.636	.639	.641	.690	.695	.697
22	.566	.568	.569	.619	.622	.624	.674	.679	.681
23	.551	.553	.554	.604	.607	.609	.659	.664	.667
24	.537	.539	.540	.591	.594	.596	.646	.652	.654
25	.524	.526	.527	.578	.582	.584	.635	.640	.642
Perpetuity	.327	.331	.332	.407	.412	.415	.487	.494	.498

Solution: 200 ÷ 0.01365 = 14,652. You would need $14,652 of life insurance, so you would have to take out another policy for about $5,000. The 1.365 percent is found in table 10 under the column headed "4 percent compounded semi-annually," opposite "7" years.

Example #3: If your widow financed, at 5 percent payable monthly over a 5-yea period, a balance of $5,000 on a well-secured first mortgage, what monthly amount would she get as principal and interest?

Solution: 0.01886 x 5,000 = $94.30 per month. The 1.886 percent is found in the column headed "5 percent compounded quarterly" of table 10, opposite 5 years. Using the percentages in the "compounded quarterly" columns of table 10 for monthly withdrawals creates very little error. 11/ The withdrawal or compounding of interest by collecting or paying it monthly, rather than quarterly, adds very little to the amount of the periodic withdrawal or payment.

Planning Life Insurance

Here is an example of life insurance programing (planning). A farmer who has dependents needs occasionally to make at least a rough estimate of the monthly income his dependents would receive if he should die. The tables and calculations may be helpful in making such an estimate.

The usual procedure in determining whether life insurance is adequate is to assume that the provider dies now. What income would dependents receive after the expenses of the last illness were met and after debts were paid?

Example: A farmer aged 37 has a wife 36 and two children aged 13 and 10. He has $20,000 of life insurance. He owes a balance of $5,000 on a mortgage. He has no "mortgage redemption" life insurance. How might he "program" his life insurance to see whether it is adequate?

Solution: He sends a card to the Social Security Administration requesting a statement of his "earnings and quarters of coverage." On the card, he enters his account number, date of birth, signature, and (printed) name and address. In response to his inquiry, he receives a statement showing that he has earned 33 quarters of coverage, and that he is fully insured and has qualified for minimum retirement benefits. The statement also shows that his covered earnings since 1950 amounted to $24,173. This total includes nonfarm wages earned before he came under social security as a farm operator in 1955. By years or periods, the statement shows the following information:

11/ For example, using table 1, the exact monthly payment (or withdrawal) is calculated as follows:

$$\frac{5{,}000 \times 1.132274}{5 \times 12} = \frac{5{,}661.37}{60} = \$94.36.$$ The 1.132274 is found in the "5 percent" column of table 1, opposite 60 monthly payments.

Period	Earnings
1951-56 ----------------	$12,728
1957 -------------------	4,200
1958 -------------------	3,123
1959 -------------------	4,122
Total for 9 years---	$24,173

The statement does not show a breakdown of his earnings by years for the 6-year period 1951-56, so unless he has kept copies of his income-tax returns or a separate record of his reported social security earnings for these years, he will not know the figures by individual years.

As only the earnings for the most recent 3 years are shown by years, the grouped period will become longer and longer, so it becomes increasingly necessary for a farmer to keep an earnings record of his own for programing purposes in connection with the dropout of the lowest 5 years of earnings. Of course, when he dies or retires, the calculations will be made for him from more detailed records available to the Social Security Administration.

At this point, we know that this farmer is fully insured, because more than half of the elapsed quarters since 1950 are covered. He has 33 quarters of a possible 36 (or 9 years x 4 quarters per year). Therefore, his family is entitled to survivorship benefits if he dies and he and his wife are entitled to at least minimum retirement benefits. Moreover, if his earnings continue at about the same level as in the past, their retirement benefits will be substantially more than the minimum. But in a programing study, we assume death now of the breadwinner, so we are primarily interested in survivorship benefits to dependents.

In calculating average annual or monthly earnings for the period 1951-59, or for any period for which the calculation is made, a dropout of the lowest 5 years is allowed, as stated previously. For use in estimating his family's survivorship income from time to time, this farmer should have copies of his income-tax returns or a separate record of his reported earnings under social security. For example, if he knew that in 1951 and 1953 he had very little or no nonfarm earnings, he could drop these years out in computing his average annual earnings. This would raise his average above the figure that will now be calculated if he had kept no records, does not remember any of the figures by years, and must assume the average for each of the 6 years.

His average for 1951-56 was $2,121 (or 12,728/6), so he drops out 5 of these 6 years.

$$\text{Average monthly wages} = \frac{24{,}173 - (5 \times 2{,}121)}{12 \times (9 - 5)} = \frac{13{,}568}{48}$$

$$= 282.67 \text{ or } \$283.$$

For average monthly wages of $283, the widow and 2 children will get $228.90 per month (column 4, table 7, opposite average monthly wages of $283).

After the older child is 18, payments to the widow and younger child drop to $153 per month (column 3, table 7, opposite average monthly wages of $283).

When the younger child is 18, the widow will be 44. As there no longer will be any dependent children under 18, and she will be under age 62, payments to her will stop. At age 62, she will start receiving checks for $84.20 (from column 2, table 7, opposite average monthly wages of $283).

Period	Years	Age of family			Payments to –	Amount
		Widow	Younger child	Older child		
1961-65-----	4	36 - 40	10 - 14	13 - 17	Widow and both children	$228.90
1965-68-----	3	41 - 43	15 - 17		Widow and younger child	153.00
1968-86-----	18	44 - 61			Widow	0
1987 on -----		62 on			Widow	84.20

If $1,000 of the proceeds from life insurance were used for expenses of the last illness, and if $5,000 were used to pay off the mortgage, that would leave $14,000 to provide for the education of the children and for a monthly income for the family. The widow will have an income from social security until the younger child is 18, at which time she will be 44, so let's see how much <u>all</u> of the $14,000 would provide as a monthly income to fill the gap between 1968, when the younger child will be 18, and 1986, when the widow (at 62) will begin receiving her social security checks for $84.20.

Using a savings and loan association

By putting all of the $14,000 into one or more savings and loan associations that pay 4 percent compounded quarterly, the fund could be built up to $18,498 between 1961 and 1968. 12/ The widow would have that amount in her account when her social security checks for $153 were stopped in 1968 because there were no longer any children under 18.

How much could she withdraw monthly from her account, beginning in 1968, in order for the fund to last 18 years (from 1968 to 1986), at which time she would be aged 62 and could start drawing her social security checks for $84.20 monthly?

Referring to table 10, we see that if she should draw out 0.65 percent (or 0.0065 as a decimal part) of the $18,498 monthly, the fund would last the full 18 years. 13/

12/ 1.3213 x 14,000 = 18,498. The 1.3213 comes from the column of table 11 headed "4 percent compounded quarterly," opposite "7" years.

13/ The 0.65 percent is found in the column of table 10 headed "4 percent compounded quarterly," opposite "18" years.

Table 11.--Compound amount of $1 if left to draw interest for periods of from 3 to 15 years, at selected interest rates

Interest period (years)	4 percent, compounded —			4 1/2 percent, compounded —			5 percent, compounded —		
	Annually	Semi-annually	Quarterly	Annually	Semi-annually	Quarterly	Annually	Semi-annually	Quarterly
	If $1 is left to draw interest, it will amount to this much at end of time								
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
3	1.1249	1.1262	1.1268	1.1412	1.1428	1.1437	1.1576	1.1597	1.1608
4	1.1699	1.1717	1.1726	1.1925	1.1948	1.1960	1.2155	1.2184	1.2199
5	1.2167	1.2190	1.2202	1.2462	1.2492	1.2508	1.2763	1.2801	1.2820
6	1.2653	1.2682	1.2697	1.3023	1.3060	1.3080	1.3401	1.3499	1.3474
7	1.3159	1.3195	1.3213	1.3609	1.3655	1.3679	1.4071	1.4130	1.4160
8	1.3686	1.3728	1.3749	1.4221	1.4276	1.4305	1.4775	1.4845	1.4881
9	1.4233	1.4282	1.4308	1.4861	1.4926	1.4959	1.5513	1.5597	1.5639
10	1.4802	1.4859	1.4889	1.5530	1.5605	1.5644	1.6289	1.6386	1.6436
11	1.5395	1.5460	1.5493	1.6229	1.6315	1.6360	1.7103	1.7216	1.7274
12	1.6010	1.6084	1.6122	1.6959	1.7058	1.7108	1.7959	1.8087	1.8154
13	1.6651	1.6734	1.6777	1.7722	1.7834	1.7891	1.8856	1.9003	1.9078
14	1.7317	1.7410	1.7458	1.8519	1.8645	1.8710	1.9799	1.9965	2.0050
15	1.8009	1.8114	1.8167	1.9353	1.9494	1.9566	2.0789	2.0976	2.1072

This would be $120 per month (or 0.0065 x 18,498). After that, she would start receiving her social security checks for $84.20, as illustrated below:

Period	Years	Age of widow	Monthly income		
			Social Security	Savings and loan association	Total
	Number	Years	Dollars	Dollars	Dollars
1961-65--:	4	36 - 40	228.90	0	228.90
1965-68--:	3	41 - 43	153.00	0	153.00
1968-86--:	18	44 - 61	0	120.00	120.00
1986 on --:		62 on	84.20	0	84.20

Using a life insurance annuity

If the $18,498 in the widow's savings and loan association account(s) in 1968 were used at that time to buy a life insurance annuity (no payments certain) at her attained age of 44, it would provide $64.50 per month. 14/ However, this $64.50 would come in for the remainder of her life, regardless of how long she lived.

If she lived beyond age 62, her total income would be $84.20 from social security plus $64.50 from life insurance. She would get this $148.70 per month as long as she lived (fig. 2). The social security survivorship benefits and the life insurance proceeds would then be as shown in the tabulation on page 35.

With this knowledge, this farmer probably would decide on more term life insurance for a while. His existing program provides too little for the widow during the "gap" period, and nothing for education of the children. Later, after the couple is older, the term insurance could be dropped. At the wife's older age, the remaining life insurance would buy for her a larger life annuity.

14/ Using the factor 3.73 from the "life annuity" column of table 5, opposite age 44, 3.73 x 18.498 = $69. But as we are assuming that the life annuity would not be obtained as an option on her husband's life insurance policy, it would actually amount to only $64.50 per month (or 0.935 x 69). Annuities not purchased through a settlement option on a life insurance policy are usually "loaded" by 6 1/2 percent for company expenses.

Period	Years	Age of widow	Monthly income: Social security	Monthly income: Life insurance	Monthly income: Total
	Number	Years	Dollars	Dollars	Dollars
1961-65	4	36-40	228.90	0	228.90
1965-68	3	41-43	153.00	0	153.00
1968-86	18	44-61	0	1/ 64.50	1/ 64.50
1986 on		62 on	84.20	1/ 64.50	1/ 148.70

1/ Upon request, the insurance company could arrange the widow's life annuity so she would get a constant monthly income from 1968 on. Under this arrangement, she would get $96.46 from life insurance during the period 1968-86, and nothing from social security. Then, from 1986 on, she would get $12.26 from life insurance and the $84.20 from social security, making a total of $96.46 per month for the later as well as the earlier period. These life-annuity calculations are based on the 1937 Standard Annuitant's Mortality Table and a 2 1/2 percent interest rate, with the widow's age 6 years less than actual. They include a loading of 6 1/2 percent for company expenses.

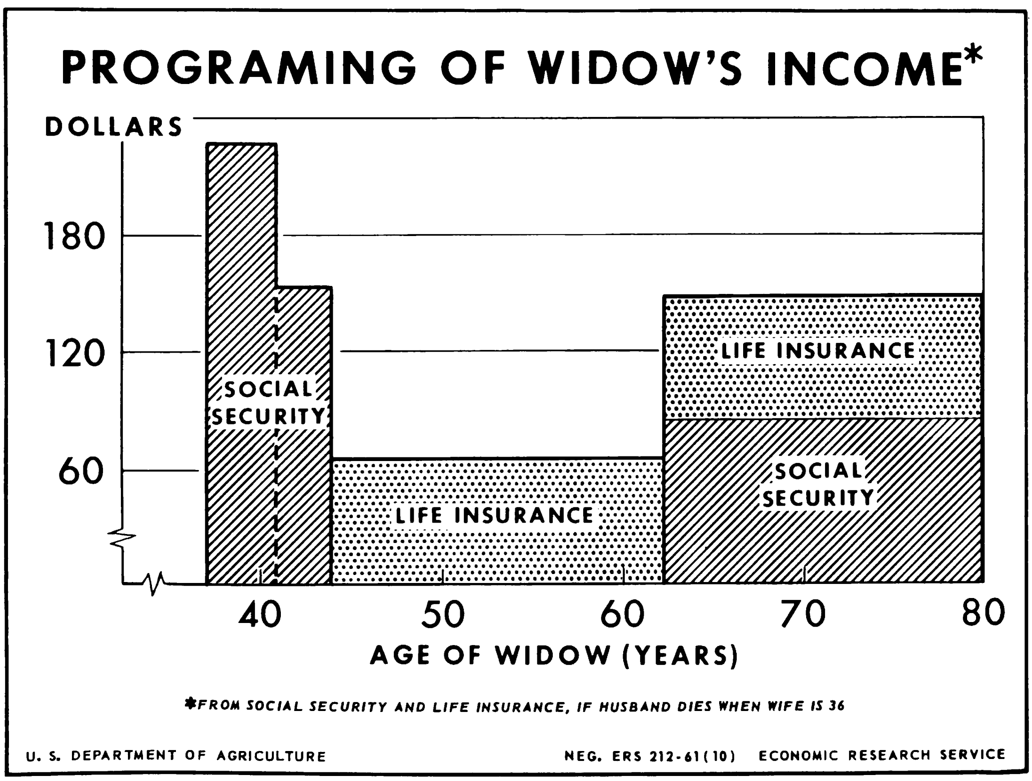


Figure 2

Estimating Yields Per Acre in the Field

Corn

$$\text{Yield per acre in 70-pound baskets of ear corn} = \frac{\text{ears counted on row of prescribed length (see below) x 100}}{\text{number of ears in 70-pound (2-bushel) basket (see below)}}$$

If distance between rows is –	Count the ears of corn on a row of this length:
3 feet 0 inches	145 feet
3 " 2 "	137 "
3 " 4 "	131 "
3 " 6 "	124 "
3 " 8 "	119 "

Ear length (average)	Number required to weight 70 pounds
10 inches and over	80
9 inches	90
8 "	100
7 "	130
6 "	180
5 "	225
4 "	260

Example: What is the yield in 70-pound (2-bushel)baskets of ear corn per acre for a field in which the rows average 3 feet 4 inches apart?

Solution: Measure off 131 feet on a row and count the ears. Suppose there are 65. They average 7 inches in length.

Then $\frac{65 \times 100}{130}$ = 50 baskets per acre.

From the 50 (2-bushel) baskets of ear corn would be obtained 50 bushels of shelled corn.

Cotton

Yield per acre (lint) = bolls (or empty burrs) counted on prescribed distance (see below) x 0.5 15/

15/ There are about 200 bolls of seed cotton to 1 pound of lint cotton. The footage measurements in the tabulation are for 1/100 of an acre. Multiplying the boll count by 100 puts the count on an acreage basis; then dividing the result by 200 gives pounds of lint per acre. But 100/200 equals 1/2, so 0.5 is used in the computation.

If distance between rows is –	Count the bolls (or empty burrs) on a row of this length:
3 feet 0 inches	145 feet
3 " 3 "	135 feet
3 " 6 "	125 feet

Example: What is the lint yield per acre on a field with rows planted 3 feet 3 inches apart?

Solution: Measure off 135 feet on a typical row and count the bolls. Suppose there are 1,200.

Then 1,200 x 0.5 = 600 pounds of lint.

OR count the bolls (or empty burrs) on half the distances shown in above table, and use the count as a poundage figure. In example:

Count of 600 bolls = 600 pounds of lint.
(Count made on row 67 1/2 feet long).

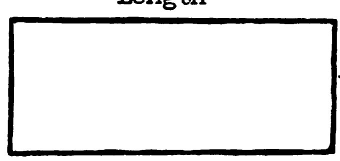
Acreage

1 acre = 43,560 square feet = 4,840 square yards.

$$\text{Acres} = \frac{\text{area in square feet}}{43{,}560} = \frac{\text{area in square } \cancel{\text{years}} \text{ yards}}{4{,}840}.$$

Rectangular fields

$$\text{Acres} = \frac{\text{length x width (in feet)}}{43{,}560} = \frac{\text{length x width (in yards)}}{4{,}840}$$

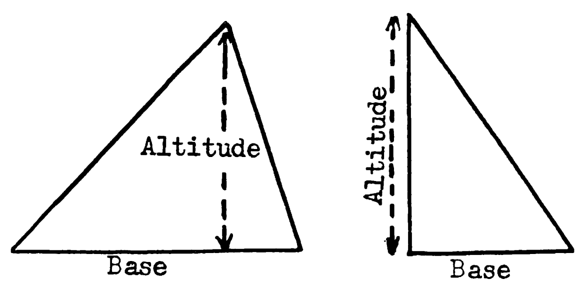


Example: A field measures 3,242 by 1,624 feet. How many acres are there?

Solution: $$\frac{3{,}242 \times 1{,}624}{43{,}560} = 120.9 \text{ acres}.$$

Triangular fields

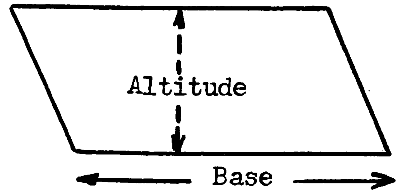
$$\text{Acres} = \frac{\text{base x altitude}}{2 \times 43{,}560}$$



Example: A triangular field has a base of 5,000 feet and an altitude of 3,000 feet. How many acres are in the field?

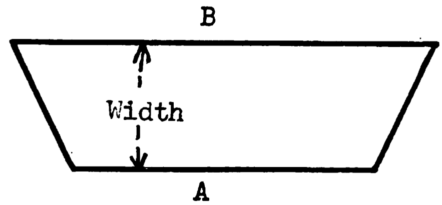
Solution: $\frac{5,000 \times 3,000}{2 \times 43,560} = 172.2$ acres.

Opposite sides parallel (parallelogram)



$$\text{Acres} = \frac{\text{base x altitude (in feet)}}{43,560} = \frac{\text{base x altitude (in yards)}}{4,840}$$

Example: How many acres are in a field, opposite sides parallel, for which the base measures 4,840 feet and the altitude measures 3,260 feet?



Solution:

$$\frac{4,840 \times 3,260}{43,560} = 370 \text{ acres.}$$

$$\text{or } \frac{1613\ 1/3 \times 1086\ 2/3}{4,840} = \frac{4,840 \times 3,260}{3 \times 3 \times 4,840} = 370 \text{ acres.}$$

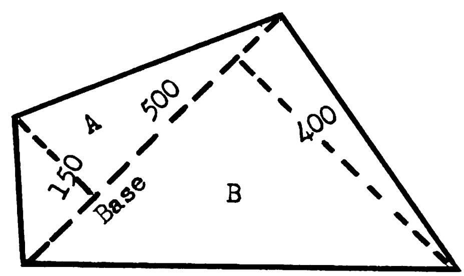
Two sides parallel

$$\text{Acres} = \frac{(A+B) \times \text{width}}{2 \times 43,560}$$

Example: How many acres in a field with side A measuring 900 feet and B measuring 1,200 feet, with a width of 600 feet?

Solution: $\frac{(900 + 1,200) \times 600}{2 \times 43,560} = 14.5$ acres.

No two sides parallel



Divide into two triangles with common base; find areas separately and add.

Example: Area of field in illustration.

Solution: Triangle A has an altitude of 150 feet; triangle B, 400 feet. The common base measures 500 feet.

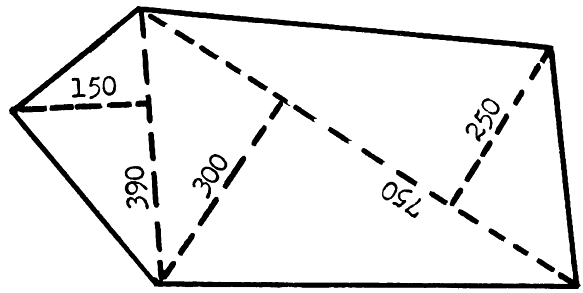
$$\text{Acres} = \frac{500 \times 150}{2 \times 43{,}560} + \frac{500 \times 400}{2 \times 43{,}560}$$

$$= \frac{500 \times (150 + 400)}{2 \times 43{,}560}$$

$$= \frac{500 \times 550}{2 \times 43{,}560} = 3.2 \text{ acres.}$$

More than four sides

Divide into triangles, find area of each; then add.



Example: Area of field in illustration.

Solution:

$$\text{Acres} = \frac{(150 \times 390) + (750 \times 300) + (750 \times 250)}{2 \times 43{,}560}$$

$$= \frac{58{,}500 + 750(300+250)}{87{,}120} = \frac{58{,}500 + (750 \times 550)}{87{,}120}$$

$$= \frac{58{,}500 + 412{,}500}{87{,}120} = \frac{471{,}000}{87{,}120}$$

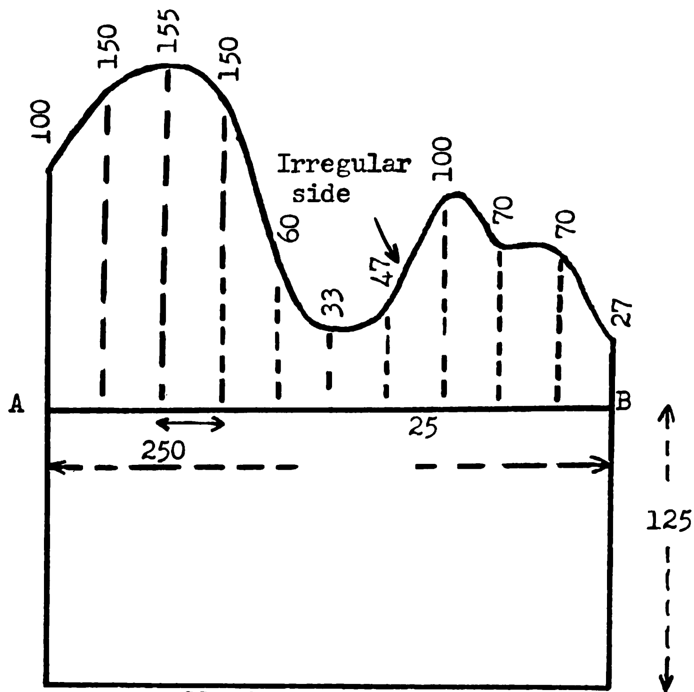
$$= 5.4 \text{ acres.}$$

Irregular boundaries

Somewhere below the irregular boundary, lay off a straight line (AB) between opposite ends of the field. Measure the length of this line. 16/ At regular intervals along this line, measure perpendicular lines between AB and the irregular side. Be sure these perpendiculars are uniformly spaced. 17/ In the example, these perpendiculars vary in length from 27 to 155 feet. The approximate area of that part of the field between AB and the irregular boundary is then, (1/2 of the sum of the two end perpendiculars, plus the sum of all other perpendiculars) multiplied by the uniform spacing between perpendiculars.

16/ In the example, it is 250 feet.
17/ In example, every 25 feet.

Example: Area of field in illustration.



Solution:

$$\text{Area between AB and the irregular side} = 25 \times \left[\frac{100+27}{2} + 150 + 155 + 150 + 60 + 33 + 47 + 100 + 70 + 70\right]$$

$$= 25 \times 898.5$$

$$= 22{,}462 \text{ square feet.}$$

$$\text{Area of remainder of field} = 125 \times 250 = 31{,}250 \text{ square feet.}$$

The area of the remainder of the field is then added to the area of the portion bounded by the irregular side, to determine the total area. The total area in the field is then divided by 43,560 to determine the acreage:

$$\frac{22{,}462 + 31{,}250}{43{,}560} = 1.2 \text{ acres.}$$

Shelled corn or grain in bin

Rectangular bin

Bushels = 0.8 x volume = 0.8 x length x width x average depth

Example: A crib 18 feet long and 12 feet wide is filled with shelled corn to an average depth of 8 feet. How many bushels are there?

Solution: 0.8 x 18 x 12 x 8 = 1,382 bushels.

Round bin

Bushels = 0.6283 x diameter x diameter x average depth 18/

Example: A round crib 12 feet 5 inches in diameter is filled with shelled corn to an average depth of 6 feet 4 inches. How many bushels are there?

Solution:

12 ft. 5 in. = 12.4 ft.
6 ft. 4 in. = 6.3 ft.

Then 0.6283 x 12.4 x 12.4 x 6.3 = 609 bushels.

Ear corn in crib (shelled basis)

If dry, bushels = 4/9 x volume.
If new, bushels = 4/10 x volume.
If damp, bushels = 4/11 x volume.

Rectangular crib

Volume = length x width x average depth.

Example: A crib 18 feet long and 12 feet wide is filled with new ear corn to an average depth of 8 feet. How many bushels are there?

Solution: 4/10 x 18 x 12 x 8 = 691 bushels.

18/ The volume of a cylindrical bin is 22/7 x radius x radius x average depth. Expressing the radius as diameter/2, one might express the volume as 22/28 x diameter x diameter x average depth. The 22/28 is 0.7854. Multiplying by 0.8, the fractional part of a bushel in 1 cubic foot, gives 0.6283.

Round crib

Volume = 0.7854 x diameter x diameter x average depth

Example: A crib 10 feet in diameter is filled with dry ear corn to a depth of 6 feet 6 inches. How many bushels are there?

Solution: 4/9 x 0.7854 x 10 x 10 x 6.5 = 227 bushels.
(6 feet 6 inches = 6.5 feet.)

Alternative (weight) method for either rectangular or round cribs

Bushels of shelled corn (if ear corn were shelled) = pounds of corn (to nearest tenth) shelled from 5-pound sample of ear corn

$$\times \frac{\text{cubic feet of earn corn in crib}}{10}$$

Example: How many bushels of shelled corn are there in a crib containing 1,000 cubic feet of ear corn? (The ears are not filled out to standard.)

Solution: 5 pounds of ear corn from the crib are shelled. The shelled corn weighs 3.2 pounds.

$$\text{Then } 3.2 \times \frac{1{,}000}{10} = 320 \text{ bushels.}$$

If 10 pounds of ear corn are shelled, divide cubic feet by 20, instead of 10. In this example:

$$6.4 \times \frac{1{,}000}{20} = 320 \text{ bushels.}$$

Deduction for studding (for greater accuracy)

Bushels to be deducted = number of studs x depth x figure from table below.

Studs	Multiply by	
	For grain	For ear corn (on shelled basis)
2 by 4 inches--------	0.044	0.022
2 by 6 inches--------	.067	.033
2 by 8 inches--------	.089	.044

Shelled corn or grain

Example: A crib 18 by 12 feet contains shelled corn to a depth of 8 feet. On page 41, it was found that the crib contains 1,382 bushels, without deducting for studding.

If this crib has thirty 2- by 4-inch studs, how many bushels must be deducted from 1,382 to get net bushels which allow for displacement of grain by the studding?

Solution: 30 x 8 x 0.044 = 11 bushels.

Then 1,382 - 11 = 1,371 bushels net.

Ear corn (shelled basis)

Example: A crib 10 feet in diameter is filled with dry ear corn to a depth of 6 feet 6 inches. Without allowing for studding, we found on page 42 that the crib contained 227 bushels of shelled corn.

If the crib has twelve 2- by 6-inch studs, how many bushels must be deducted from 227 to get net bushels?

Solution: 12 x 6.5 x 0.033 = 2.574, or about 3 bushels.

Then 227 - 3 = 224 bushels net.

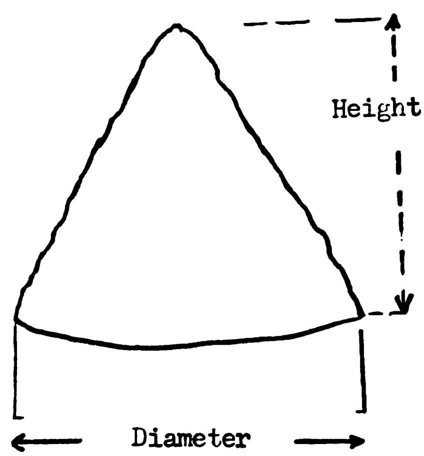
Piled grain

Shelled corn, small grains, and so on

Bushels = 0.20944 x height x diameter of base x diameter of base.

Example: How many bushels of wheat are there in a cone-shaped stack 10 feet high and 30 feet across the base?

Solution: 0.20944 x 10 x 30 x 30 = 1,885 bushels.



Ear corn (shelled basis)

Bushels = 0.10472 x height x diameter of base x diameter of base.

Example: How many bushels of shelled corn are there in a stack of ear corn 10 feet high and 30 feet across the base?

Solution: 0.10472 x 10 x 30 x 30 = 1/2 of 1,885 (see above example) = 942.5 bushels.

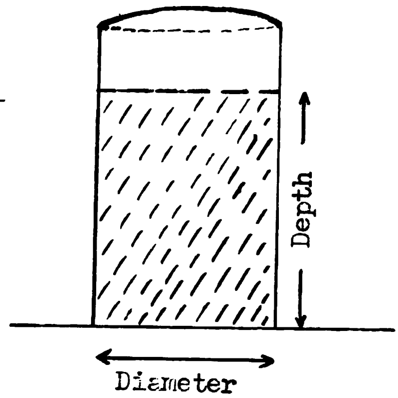
By volume, 1 cubic foot of ear corn makes about 0.4 bushel of shelled corn. A 2-bushel basket of ear corn makes 1 bushel of shelled corn.

By weight, the 2-bushel basket weighs about 70 pounds. It contains 56 pounds of shelled corn (1 bushel) and 14 pounds of cobs (also 1 bushel). Therefore, by weight, the corn is about 80 percent grain and 20 percent cobs.

Corn silage in round silo

$$\text{Tons} = \frac{0.7854 \text{ x depth of silage x diameter x diameter}}{\text{Cubic feet per ton (see tabulation below)}}$$

Depth of settled silage (feet)	Cubic feet per ton	Depth of settled silage (feet)	Cubic feet per ton
14----------	55.3	30---------	51.3
16----------	54.5	32---------	51.0
18----------	54.0	34---------	50.7
20----------	53.3	36---------	50.5
22----------	53.0	38---------	50.3
24----------	52.5	40---------	50.1
26----------	52.1	42---------	49.9
28----------	51.7	44---------	49.7



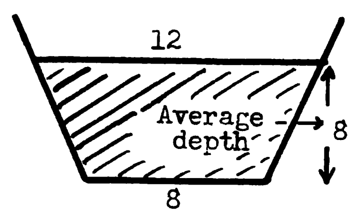
Example: A silo 16 feet inside diameter has 30 feet of silage in it. How many tons are there?

Solution: $\frac{0.7854 \text{ x } 30 \text{ x } 16 \text{ x } 16}{51.3} = 117.6$ tons.

Corn silage in trench silo

Tons = average width x length x depth of silage x tons per cubic foot of depth (see tabulation below).

Depth of settled silage (feet)	Tons per cubic foot	Depth of settled silage (feet)	Tons per cubic foot
1 -----------	0.00925	9----------	0.01320
2 -----------	.00985	10---------	.01365
3 -----------	.01040	11---------	.01405
4 -----------	.01090	12---------	.01445
5 -----------	.01140	13---------	.01490
6 -----------	.01190	14---------	.01530
7 -----------	.01235	15---------	.01565
8 -----------	.01280		



Example: A trench silo measures 8 feet wide at the bottom and 12 feet wide at the top. The silage averages 8 feet deep and the silo is 50 feet long. How many tons are there?

Solution: $\left[\frac{8 + 12}{2}\right] \times 50 \times 8 \times 0.0128 = 51.2$ tons.

Hay in mow

Tons = volume ÷ a figure ranging from 435 to 640 (see tabulation below, which applies to both hay in mow and hay in stack).

Volume = length x width x average depth.

Example: Timothy hay, 2 months old, fills a mow 30 by 40 feet to an average depth of 9 feet 9 inches. How many tons are in the mow?

Solution: $\frac{30 \times 40 \times 9.75}{640} = 18.3$ tons.

Kind of hay	Cubic feet per ton	
	If in stack 30-90 days	If in stack more than 90 days
Alfalfa	485	470
Clover	450 to 485	435 to 470
Timothy	640	625
Wild	600	450

Hay in stack

Tons = $\frac{0.3 \times \text{length} \times \text{width} \times \text{overthrow}}{\text{A figure ranging from 435 to 640 (from tabulation above)}}$ [19]

Example: Approximately how many tons of alfalfa hay are in a stack 26 by 23 feet with an overthrow of 48 feet? The hay was harvested more than 3 months ago.

Solution: $\frac{0.3 \times 26 \times 23 \times 48}{470} = 18.3$ tons.

19/ Overthrow is the distance in feet over the stack from the ground on one side to the ground on the other side.

Gallons of water in tank or cistern

Rectangular

Gallons = length x width x depth x 7.48 [20]

Example: How many gallons in a tank 12 feet 2 inches by 6 feet 4 inches by 5 feet 3 inches?

Solution: $12\ 1/6 \times 6\ 1/3 \times 5\ 1/4 \times 7.48$

which is $\frac{73 \times 19 \times 21 \times 7.48}{6 \times 3 \times 4} = 3{,}026$ gallons.

Cylindrical

$$\text{Gallons} = \frac{22 \times \text{diameter} \times \text{diameter} \times \text{height} \times 1.87}{7}$$

Example: How many gallons in a tank 5 feet 4 inches in diameter and 7 feet 8 inches high?

$$\text{Solution: } \frac{22 \times 5\ 1/3 \times 5\ 1/3 \times 7\ 2/3 \times 1.87}{7}$$

$$= \frac{22 \times 16 \times 16 \times 23 \times 1.87}{7 \times 3 \times 3 \times 3} = 1{,}282 \text{ gallons.}$$

Moisture content of corn

Following are correction factors for converting gross bushels of ear corn to net bushels:

Moisture content (percent)	Factor	Moisture content (percent	Factor	Moisture content (percent)	Factor
15 or less	1.030	22	0.925	29	0.820
16	1.015	23	.910	30	.805
17	1.000	24	.895	31	.790
18	.985	25	.880	32	.775
19	.970	26	.865	33	.760
20	.955	27	.850	34	.745
21	.940	28	.835	35	.730

20/ 1,728/231 = 7.48. Multiplying cubic feet by 1,728 converts to cubic inches. Then dividing by 231 gives gallons. There are 231 cubic inches in one gallon.

Example: In an earlier example (page 41), it was estimated that there were 691 bushels of shelled corn in a rectangular crib 18 feet long and 12 feet wide, filled with new ear corn to an average depth of 8 feet. Suppose a sample of it shows the corn to have a moisture content of 23.3 percent. How many net bushels of shelled corn are there?

Solution: The 23.3 percent moisture content is rounded to 23 percent before entering the above tabulation. Then 0.91 x 691 = 628.8, or 629 bushels. The 91 percent comes from the tabulation given above.

Conversion of bushels by volume to bushels by weight

Test weight of 1 bushel (pounds)	Wheat, soybeans, and beans	Flax, shelled corn, grain sorghum, and rye	Barley
	Multiply bushels by volume by this figure to obtain bushels by weight		
64	1.07	---	---
62	1.03	---	---
60	1.00	1.07	---
58	.97	1.04	---
56	.93	1.00	---
54	.90	.96	---
52	.87	.93	1.08
50	.83	.89	1.04
48	.80	.86	1.00
46	.77	.82	.96
44	.73	.79	.92
42	.70	.75	.87
40	.67	.71	.83
38	.63	.68	.79
36	.60	.64	.75

Example: After deducting for displacement of grain by studding, we found in an earlier example (page 43) that there were 1,371 bushels of shelled corn in a rectangular bin 18 feet long and 12 feet wide, filled to an average (leveled) depth of 8 feet. If a bushel of the corn weighs 46 pounds by test, how many standard-weight bushels are in the crib?

Solution: 0.82 x 1,371 = 1,124 bushels by weight. The 0.82 comes from the above tabulation. Since there are 56 pounds of shelled corn in a standard bushel, 46 ÷ 56 = 0.82.

Estimating Quantities of Building Materials Needed

Board feet

Board feet = (number of pieces x nominal thickness in inches x nominal width in inches x length in feet) ÷ 12.

Example: How many board feet are in nine 2 by 4's fourteen feet long?

Solution: $\frac{9 \times 2 \times 4 \times 14}{12}$ = 84 board feet.

Concrete

Volume = $\frac{\text{length in feet x width in feet x thickness in inches}}{27 \times 12}$

= answer in cubic yards.

Example: How much concrete mix will it take to make a sidewalk 52 feet long, 2 feet 3 inches wide, and 4 inches thick?

Solution: $\frac{52 \times 2\ 1/4 \times 4}{27 \times 12} = \frac{52 \times 9 \times 4}{27 \times 4 \times 12}$ = 1 4/9 cubic yards.

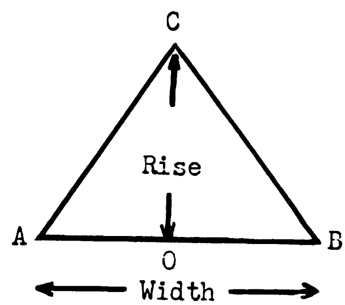
The 2 1/4 in numerator = 9/4.
Omit the 27 in denominator and answer is in cubic feet; answer, 39 cubic feet.

Rafter length

Rafter length = square root of (1/4 of width squared + rise squared.)

Example: A building 32 feet wide (distance AB) is to have a rise of 12 feet (distance OC). What rafter length (distance AC) is required?

Solution: Rafter length = square root of (1/4 x 32 x 32) + (12 x 12). The square root of 256 + 144 = square root of 400 = 20 feet. (Proof: 20 x 20 = 400.)



Wallpaper

Single rolls ... 18 inches wide and 24 feet long ... 36 square feet.
Double rolls ... 18 inches wide and 48 feet long ... 72 square feet.

Rolls required = $\frac{1.1 \left[\text{square feet in walls or ceiling} - \text{square feet in openings (windows and doors)}\right]}{\text{36 or 72 ... depending on whether you use single or double rolls.}}$ 21/

21/ Allows 10 percent for waste and for matching needs.

Example: A room 7 feet high is 13 feet wide and 18 feet long. It contains 3 doors, 6 feet 2 inches by 2 feet 8 inches; and 2 windows, 4 feet by 2 feet 6 inches. How many single rolls of wallpaper are required to cover the walls? Double rolls to cover the ceiling?

Solution:

For the walls (less openings) ... $1.1 \left[(2 \times 7 \times 13) + (2 \times 7 \times 18) - (3 \times 6\ 1/6 \times 2\ 2/3) - (2 \times 4 \times 2.5)\right] \div 36$

$= 1.1\left[(182 + 252 - 49\ 1/3 - 20)\right] \div 36$

$= (1.1 \times 364\ 2/3) \div 36 = 401.133/36$

$= 11.1$, or 12 single rolls.

For the ceilings ... $\frac{1.1(13 \times 18)}{72} = \frac{1.1 \times 234}{72} = \frac{257.4}{72}$

$= 3.6$, or 4 double rolls.

Joists (16 inches on center)

Number required = (0.75 x length) + 1.
Allow 4 to 6 inches at each end for bearing on wall.

Allowance for waste

	Add to area for waste
Sheathing:	
Common:	
Laid horizontally (without openings in wall)	1/10
For dwellings .. figure as though without openings	0
Laid diagonally	1/6
Tight:	
Laid horizontally:	
6-inch boards	1/5
8-inch boards	1/7
10-inch boards	1/9
Laid diagonally:	
6-inch boards	1/4
8-inch boards	1/6
10-inch boards	1/8
Flooring:	
3-inch matched	1/2
4-inch matched	1/3
6-inch matched	1/5
Siding:	
Drop	1/5
Lap:	
4 inches to weather	1/2
4 1/2 inches to weather	1/3

Example: How many board feet of 1 by 6-inch sheathing laid tight diagonally are required to cover a wall 10 feet 3 inches by 18 feet 4 inches?

Solution: $1.25 \times 10\ 1/4 \times 18\ 1/3 = 1.25 \times \frac{41}{4} \times \frac{55}{3}$

$$= \frac{1.25 \times 41 \times 55}{4 \times 3} = \frac{2818.75}{12}$$

= about 235 board feet.

Multiplying by 1.25 adds 25 percent for waste.

Paint

Area to be painted	Gallons per 100 square feet: First coat	Second coat
Exterior:		
Siding	0.22	0.20
Interior:		
Woodwork	.25	.17
Plaster walls or ceiling	.20	.18

Example: How many gallons of paint would be required to put a first coat of paint on the plastered walls of the room used in example on page 49? It is 18 feet long, 13 feet wide, and 7 feet high, and has 3 doors, 6 feet 2 inches by 2 feet 8 inches, and 2 windows, 4 feet by 2 feet 6 inches?

Solution: In the wallpaper example, it was found that there were 364 2/3 square feet after excluding the area in doors and windows.

Then $\frac{0.20 \times 364\ 2/3}{100} = \frac{0.2 \times 364.667}{100} = 0.2 \times 3.64667$,

which is about 0.73, or 3/4 gallon.

APPENDIX

To save work ... Try this way of solving some simple problems.

Steps

1. Draw a horizontal division line.
2. Make entries above and below this line, depending on whether the operation requires multiplication or division.
3. Cancel where possible. Cancellation often will eliminate much of the work and speed up your calculations.

Table 12.--Conversion factors 1/

Commodity	Unit	Approximate equivalent
Apples	1 pound dried	8 pounds fresh (beginning 1943)
Barley	1 metric ton 2/	45.93 bushels
Barley flour	100 pounds	4.59 bushels barley
Beans, snap or wax	1 case canned 3/	0.010 tons fresh
Calves	1 pound live weight	0.555 pounds dressed weight (since 1952)
Cattle	1 pound live weight	0.549 pounds dressed weight (since 1952)
Chickens	1 pound live weight	0.72 pound ready-to-cook weight
Corn	1 metric ton 2/	39.368 bushels
Corn, shelled	1 bushel (56 pounds)	2 bushels (70 pounds) of husked corn
Cotton	1 pound ginned	3.26 pounds seed cotton including trash 4/
Cottonseed meal	1 pound	2.10 pounds cottonseed
Cottonseed oil	1 pound	5.88 pounds cottonseed
Dairy products		
Butter	1 pound	21.1 pounds milk
Cheese	1 pound	10 pounds milk
Nonfat dry milk	1 pound	11 pounds liquid skim milk
Eggs	1 case	47 pounds
Flaxseed	1 bushel	About 2 1/2 gallons oil
Hogs	1 pound live weight	0.569 pounds dressed weight excluding lard (since 1952)
Oats	1 metric ton 2/	68.8944 bushels
Peanuts	1 pound shelled	1 1/2 bushels unshelled
Rye	1 metric ton 2/	39.368 bushels
Rye flour	1 metric ton 2/	2.23 bushels (beginning 1947)
Sheep and lambs	1 pound live weight	0.477 pounds dressed weight (since 1952)
Soybeans	1 metric ton 2/	36.744 bushels
Soybean meal	1 pound	1.28 pounds soybeans
Soybean oil	1 pound	5.45 pounds soybeans
Tomatoes	1 case canned 3/	0.027 ton fresh
Turkeys	1 pound live weight	0.80 pound ready-to-cook weight
Wheat	1 metric ton 2/	36.7437 bushels
Wheat flour	100 pounds	2.30 bushels wheat 5/

1/ A more complete list may be found in the front pages of the annual publication "Agricultural Statistics" of the U. S. Dept. of Agriculture. A table of weights and measures also is shown.

2/ A metric ton is equivalent to 2204.6 pounds.

3/ Case of 24 number 2 cans.

4/ Varies widely by method of harvest.

5/ This is equivalent to 4.51 bushels of wheat per barrel (196 pounds) of flour and has been used in conversions beginning July 1, 1957.

Table 13.--Measurement equivalents and formulas

CONVERSION EQUIVALENTS

12 inches = 1 foot	231 cubic inches = 1 gallon (liquid measure)
3 feet = 1 yard	268.8 cubic inches = 1 gallon (dry measure)
5,280 feet = 1 mile	2,150.42 cubic inches = 1 bushel
16 1/2 feet = 1 rod	1 cubic foot water weighs 62.4 pounds
320 rods = 1 mile	1 cord = 128 cubic feet
144 square inches = 1 square foot	31 1/2 gallons = 1 barrel
9 square feet = 1 square yard	1 pint = 16 ounces
1 inch = 2.54 centimeters	1 quart = 32 ounces
1 meter = 39.37 inches	1 peck = 8 quarts
1 square mile = 640 acres	1 bushel = 4 pecks
60 miles per hour = 88 feet per second	
1,728 cubic inches = 1 cubic foot	
27 cubic feet = 1 cubic yard	

MEASUREMENT FORMULAS

Circumference of circle = 3.1416 x diameter = $\frac{22 \text{ x diameter}}{7}$

Area of circle = .7854 x diameter x diameter

Area of rectangle = length x width

Area of triangle = 0.5 x base x altitude

Area of curved surface of cylinder (like a silo) = 3.1416 x diameter x height

Volume of sphere = .5236 x diameter x diameter x diameter

Volume of cylinder = .7854 x height x diameter x diameter

Volume of pyramid = 1/3 x area of base x altitude

Volume of cone (like a stack of grain) = .2618 x height x diameter x diameter

* U.S. GOVERNMENT PRINTING OFFICE : 1962 O—636983

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Growth Through Agricultural Progress